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Recurrent weight gain after sleeve gastrectomy: conversion to Roux-en-Y gastric bypass versus novel GLP-1 s

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Abstract

Purpose This retrospective cohort study aims to compare outcomes of Roux-en-Y gastric bypass (RYGB) versus semaglutide for treatment of recurrent weight gain (RWG) and suboptimal weight loss (SWL) after sleeve gastrectomy (SG).

Methods Patients at a tertiary care hospital who underwent RYGB conversion after SG ($n=87$) were matched 1:1 to SG patients treated with semaglutide ($n=87$) by: age, gender, race, ethnicity, pre-SG to pre-intervention total weight loss (%TWL), BMI, diabetes status, and time between SG and intervention. Semaglutide 'responders' (defined as ≥ 5% TWL at three months, $n=26$) and non-responders were similarly compared to the overall RYGB cohort. Weight, comorbidity, and complication outcomes were collected for two years post-intervention.

Results %TWL two years post-intervention was greater in the RYGB compared to the semaglutide cohort (17.1% vs. 7.6%, mean difference = 9.5%, 95% CI [2.6, 16.4], $p=0.002$), as was the proportion of patients who achieved > 10% TWL (82.6% v. 40.9%, $p<0.001$). Diabetes medications ($p=0.018$) and mean HbA_{1c} ($p=0.006$) decreased significantly in the RYGB but not semaglutide cohort. RYGB patients had increased frequencies of GI surgeries and endoscopies. For semaglutide 'responders,' two-year %TWL was similar to RYGB (22.9% vs. 17.1%, $p=0.423$).

Conclusions RYGB led to greater and more consistent weight loss and diabetes control than semaglutide in SG patients with RWG, at the cost of an increased need for GI interventions. While only a minority of patients responded to semaglutide, these patients had similar two-year weight outcomes as RYGB.

Keywords Recurrent weight gain · Sleeve gastrectomy · Semaglutide · GLP-1 agonist · RYGB · Bariatric surgery

Introduction

Worldwide, sleeve gastrectomy (SG) is the most performed metabolic and bariatric surgery (MBS) due to the technical ease of the operation and lower morbidity rates compared to other operations such as Roux-en-Y gastric bypass (RYGB) [1, 2]. SG provides durable long-term weight loss and comorbidity improvement, on average; however, a significant subset of patients will experience recurrent weight gain (RWG) or suboptimal weight loss (SWL) [3–10]. Causes of RWG and SWL after SG are multifactorial, including patient factors such as differences in post-operative hormonal regulation, dysregulated eating, low levels of physical activity, and lifestyle stressors, as well as differences in technical factors during the operation; however, poor surgical technique and patient noncompliance are rarely the cause of RWG and SWL [8, 11, 12]. RWG and SWL carry consequences for patients including recurrence of obesity-related complications, increased financial burden associated with healthcare needs, and negative impact on quality of life [8].

The optimal management of patients experiencing RWG and SWL has not yet been determined; however, SG conversion to RYGB is the most performed revision surgery [13]. Recently, the 10-year follow-up of the SM-BOSS

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RCT showed that 30% of patients randomized to the SG arm required conversion to RYGB for GERD (47% of indications), RWG (28%), or both RWG and GERD (19%), compared to 5% of RYGB patients requiring reoperation [10]. Regardless of the indication for conversion, conversion surgery has been shown to lead to further weight loss for patients [14, 15], with some studies demonstrating mean percent total weight loss (%TWL) of > 20% at one year after the conversion surgery [16, 17].

The introduction of long-acting GLP-1 agonists for weight loss has altered non-surgical management of obesity. Higher levels of endogenous GLP-1 after MBS have been associated with successful weight loss for patients, which supports a mechanism for GLP-1 agonists as a viable treatment mechanism for RWG and SWL after MBS [18]; the BARI-OPTIMISE randomized controlled trial demonstrated that adjuvant liraglutide led to approximately 9% TWL after 24 weeks for patients with RWG or SWL after MBS [19]. Compared to liraglutide, semaglutide produces significantly greater weight loss amongst patients with obesity [20]. For patients experiencing RWG and SWL, studies have shown that post-operative treatment with semaglutide produces 3.7–14.7% mean weight loss at or after 12 months [21, 22]. Additionally, the literature describes a subset of "responder" patients with early or successful weight loss with these medications, often defined as 5% TWL at around three–four months on the medication [23, 24]. These studies demonstrate that, beyond the initial management of obesity, GLP-1 agonists may become a significant contributor to the treatment of RWG and SWL.

In the rapidly changing landscape of obesity management, there is a dearth of studies directly comparing results of patients treated with semaglutide to those who underwent a conversion to RYGB for the management of RWG or SWL (henceforth collectively referred to as RWG). The goal of our study is to provide evidence for targeted counseling of patients experiencing RWG after MBS by comparing weight outcomes, comorbidity resolution, and complications for patients who were treated with semaglutide against those for whom a surgical conversion to RYGB was performed after RWG following SG. Semaglutide rather than tirzepatide was the focus of this study since the FDA approval of tirzepatide for obesity did not occur until November 2023, limiting our opportunity for two-year follow-up.

Methods

This study was approved by the Brigham and Women's Hospital Institutional Review Board (IRB #2014P001772) and the requirement for informed consent was waived for this retrospective analysis. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines.

Study design and patients

This study is a retrospective cohort study performed at a tertiary-care academic institution with a multi-disciplinary medical and surgical weight management center. From institutional patient databases, 194 patients were identified who had undergone a SG with later conversion to RYGB (SG dates ranged from 2003 to 2020, conversion dates from 2014 to 2023) (Fig. 1). Patients were excluded from the study based on the following criteria: undergoing the intervention within 6 months of the original SG (by which point patients experiencing suboptimal weight loss can be identified) ($n = 6$), lacking follow-up data after either SG or intervention ($n = 11$), not having the potential for at least one year of follow up ($n = 2$), taking semaglutide before undergoing RYGB ($n = 11$), taking semaglutide within our two-year follow-up period after RYGB ($n = 13$), and having a known pregnancy during the eligible follow-up period after intervention ($n = 3$). After exclusion, 148 patients were eligible for our study. Many patients with a BMI less than 35 kg/m^2 were receiving surgical intervention primarily for treatment of GERD rather than RWG. Therefore, to capture the effect of the intervention for RWG, we identified as our primary study cohort those patients with a pre-intervention BMI greater than or equal to 35 kg/m^2, our local criterion for MBS eligibility in the study time period [25, 26], leaving 87 patients of the original 194.

To contrast these outcomes, we identified 173 patients who met inclusion criteria and used semaglutide for greater than one month after a prior SG (2011–2022; semaglutide use 2017–2023) and did not undergo a conversion surgery within our two-year follow-up period. Patients were not excluded from the semaglutide group if they transitioned to tirzepatide during the two-year follow-up period to accurately reflect the patient experience of current medication management for RWG.

Using propensity score matching, patients who underwent RYGB conversion after SG were matched 1:1 (optimal match) to patients who started semaglutide after undergoing SG by age at time of intervention, gender, race, ethnicity, diabetes status, BMI at time of intervention, percent total weight loss (%TWL) from pre-SG to pre-intervention, and time interval between SG and intervention. These criteria were determined a priori based on consensus agreement of factors that could influence group allocation at the time of clinical treatment. Upon completing the optimal score matching, we defined two matched cohorts of 87 patients. Patient follow-up decreased over the course of the study, with greater than 55% follow-up amongst eligible patients at two years (overall follow-up included in Fig. 2). Amongst

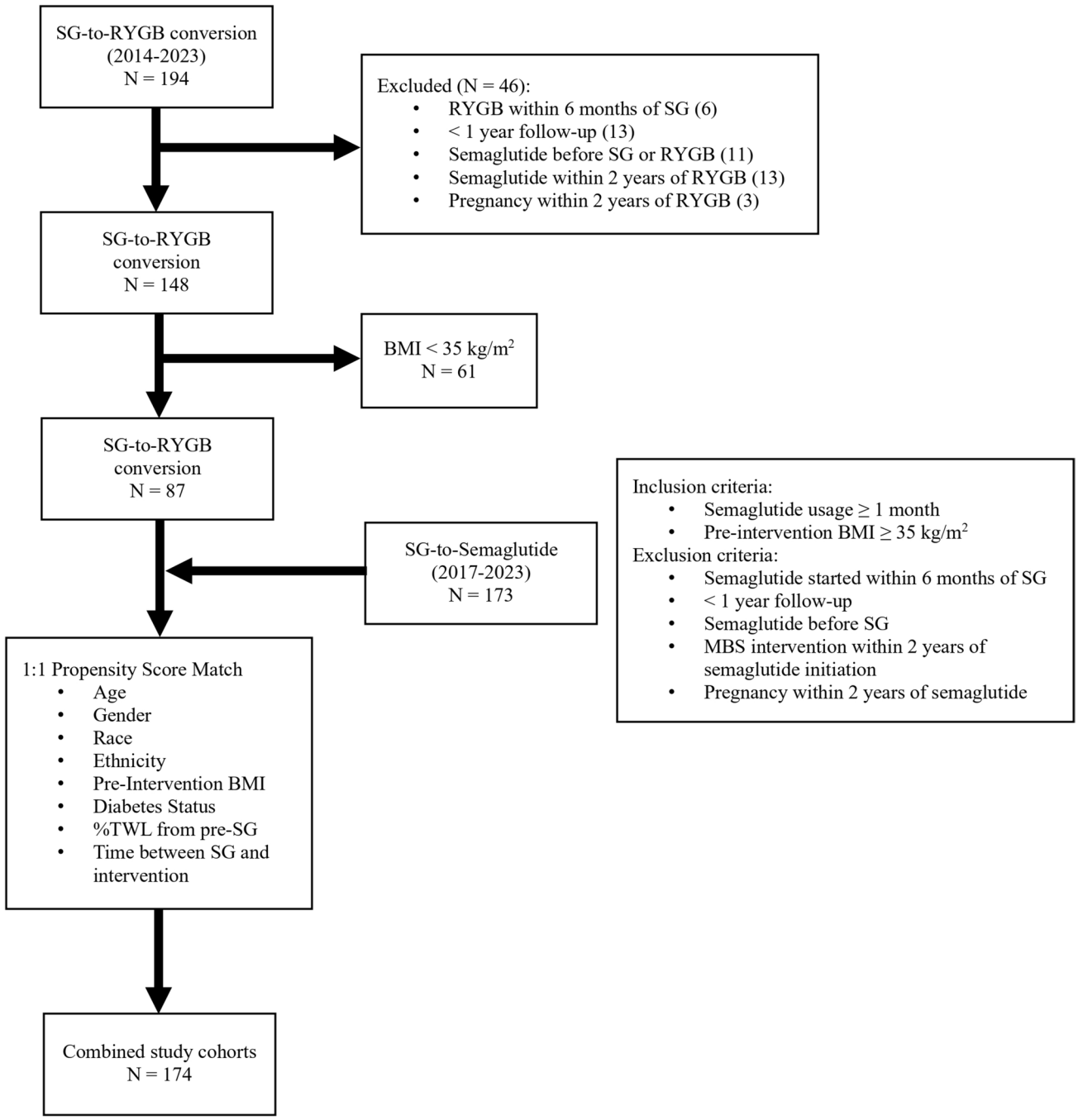
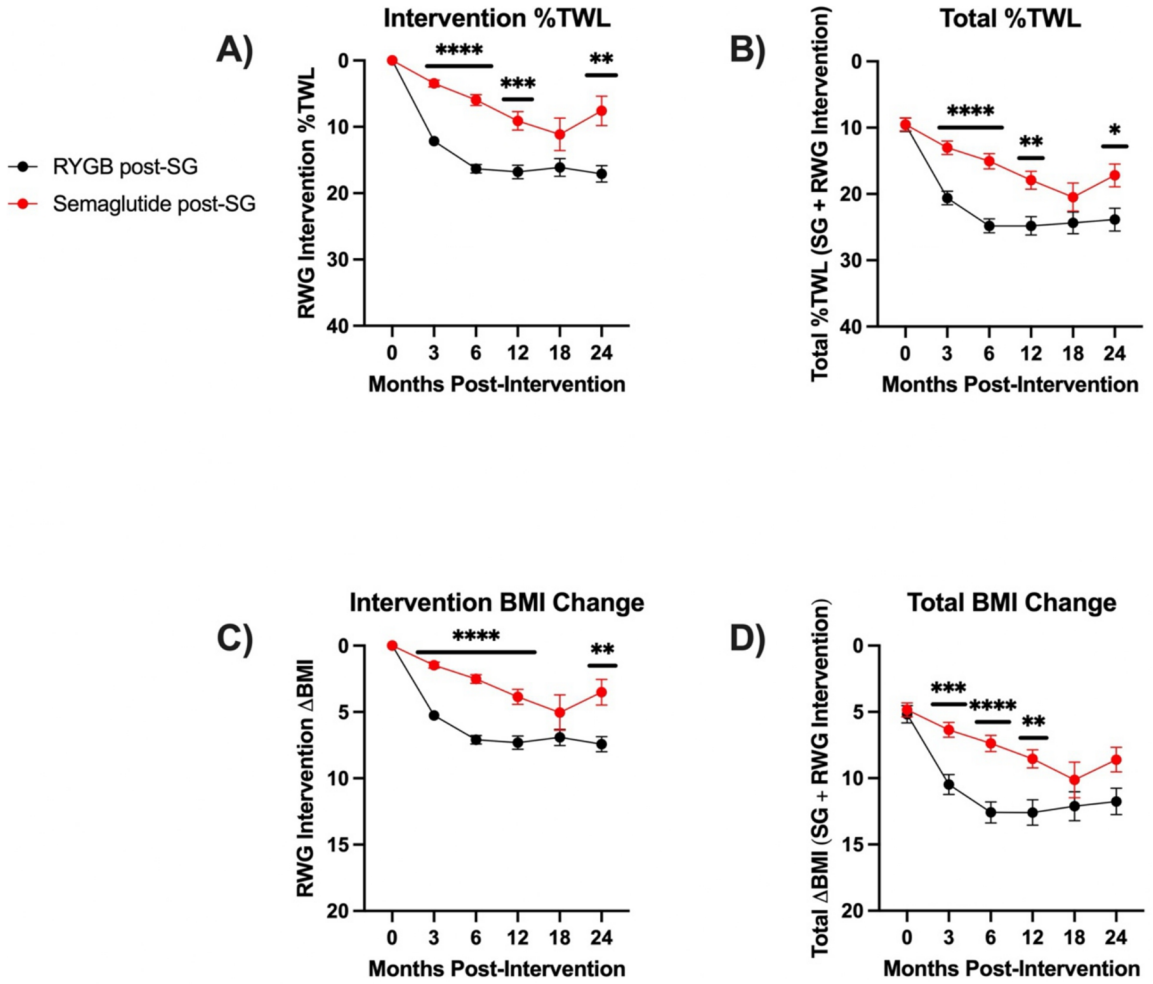


Fig. 1 Inclusion and exclusion criteria leading to creation of study cohorts. *RYGB* Roux-en-Y Gastric Bypass, *SG* sleeve gastrectomy, *%TWL* total weight loss

subgroup analyses, follow-up at two years ranged from 56 to 71% of eligible patients (Fig. 4).

Outcomes of interest

Data collection occurred from May 1, 2024 through December 31, 2024, with outcomes collected from patient electronic medical records. The main outcome of interest was two-year weight loss after intervention for RWG. To analyze all weight outcomes, patient weights were collected at 3, 6, 12, 18, and 24 months post-intervention (with a margin of ± 1.5 months for each time point; if no data was available in that time, no weight was recorded). %TWL at two years following RWG intervention was defined as [100*(pre-intervention weight – post-intervention weight)/(pre-intervention weight)] [27]. Additional weight loss metrics were %TWL



	Pre-SG	Pre-Intervention	3 months	6 months	12 months	18 months	24 months
RYGB	87/87 (100%)	87/87 (100%)	79/87 (91%)	73/87 (84%)	69/87 (79%)	54/85 (64%)	44/78 (56%)
Semaglutide	87/87 (100%)	87/87 (100%)	68/87 (78%)	69/87 (79%)	66/87 (76%)	54/85 (64%)	38/56 (68%)

Fig. 2 Weight loss of RYGB versus semaglutide following SG. Each data point reflects the mean ± standard error of the mean (SEM), $n = 87$ per cohort. Black = RYGB cohort. Red = semaglutide cohort. **A** %TWL attributable to the intervention. **B** %TWL from index SG. **C** BMI change attributable to the intervention. **D** BMI change from index SG. Significance calculated using two-way ANOVA, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.005$, **** $p < 0.0001$ (Color figure online)

from pre-SG to two years post-intervention, and absolute BMI change at two years compared to pre-intervention and pre-SG. In addition to post-intervention weight outcomes, we collected post-SG weight outcomes, including nadir weight post-SG and weight regain post-SG, defined as [100*(pre-intervention weight – nadir weight)/(pre-SG weight – nadir weight)] [28].

An additional outcome of interest was comorbidity resolution at two years following intervention. We examined patient hemoglobin A_{1c} (HbA_{1c}) levels at 3, 6, 12, 18, and 24 months, as well as the number of anti-hypertensives and diabetes medications a patient was prescribed before the intervention and at one and two years post the intervention. Finally, data on complications was examined for each intervention within the two-year follow-up period. For both RYGB and semaglutide patients, we identified all emergency department (ED) visits, hospital admissions, and 30-day severe complications, defined as unplanned ICU admissions, hospital admissions, operations, and mortality within that time. We recorded all gastrointestinal surgical operations and interventions within the two-year follow-up period. For patients undergoing RYGB, we recorded

rates of internal hernias, marginal ulcers, anastomotic leaks, dumping, dysphagia, total parenteral nutrition (TPN) requirements, chronic pain, and small intestinal bacterial overgrowth (SIBO). For patients who took semaglutide, we recorded patient reported gastrointestinal complications as well as reports of hair loss, fatigue, and diagnoses of pancreatitis.

Statistical analysis

Statistical analysis was performed in R-studio (Version 2023.12.1 + 402, Boston, Massachusetts, USA) and GraphPad Prism (for macOS, Version 10.4.0 (527), San Diego, California, USA). Propensity score matching was performed using the optimal match function in R-studio. To ensure similarity between on cohorts based on matching criteria, we performed chi-square tests for categorical variables and *t* test for continuous variables. To analyze patient weight outcomes, we performed two-way ANOVA with repeated measures utilizing a mixed-effects model using the Geisser-Greenhouse correction, as well as Šídák's multiple comparison test correction. To assess the relationship between SG outcomes (nadir weight after SG, weight regain post-SG, and interval between SG and intervention) and intervention %TWL at 1 year, we performed a simple linear regression. One year %TWL was selected due to greater patient follow up at that time compared to 2 years. In these analyses, one patient was removed from analysis in the RYGB cohort when analyzing impact of the interval between SG and intervention due to the time being greater than eight standard deviations away from the mean, and two patients were removed from the semaglutide cohort when analyzing weight regain as their regain was greater than three standard deviations from the mean. Sub-group analysis was performed to compare weight outcomes between patients who responded well to semaglutide ('responders') and a matched cohort of RYGB patients. 'Responder' subgroups were defined in our study as %TWL of ≥ 5% at three months since the start of medication use, consistent with the American Diabetes Association definition of "early responders" as well as insurance policy requirements for continued medication coverage [23, 24]. Propensity score matching to identify a matched RYGB was performed using the same criteria as the overall population (Supplemental Fig. 1, Supplemental Table 2). Weight outcomes were calculated the same as the overall population. Patient HbA_{1c} trends were analyzed with both two-way ANOVA with repeated measures, and with paired *t* test analyzing the mean difference in HbA1c from pre-intervention to two years post-intervention. Patient medication changes as a proxy for comorbidity resolution was analyzed using chi-square tests to assess overall differences in resolution, and with Yates correction to compare the percent of patients that improved, worsened or were stable for each comorbidity. Comparisons of the number of patients who had complications were calculated using chi-square tests with Yates correction. The level of significance was set to 0.05.

Power calculation

A priori power analysis performed using G*Power version 3.1.9.7, with the level of significance set to 0.05 and power set to 80%, determined that a sample size of 90 (45 patients in each cohort) was required to detect a difference of 5.3% in the %TWL at 12 months post intervention, based on prior studies demonstrating 12-month %TWL of 20.0 ± 4.4% [16] after RYGB conversion, and 14.7 ± 8.8% after 12 months on semaglutide after MBS [21]. There were limited studies of comparable criteria with data for 24-month outcomes for patients, thus 12-month outcomes were used for power calculations. Given our sample size of 174, the study was appropriately powered for our main analysis.

Results

Patient characteristics

We performed a retrospective case–control study comparing patients with a BMI ≥ 35 kg/m^2 suffering from RWG after prior SG and who underwent RYGB conversion surgery to a matched cohort of patients with a BMI ≥ 35 kg/m^2 who took semaglutide for RWG after SG. Patient demographics were well matched between the RYGB and semaglutide cohorts (Table 1). The average age of patients at the time of their intervention was 41.8 and 43.6 years old respectively. Both populations were predominantly female (90.8%, 90.8%), white (66.7%, 71.3%), and non-Hispanic (75.9%, 81.6%). Most patients did not have type II diabetes (T2D) (58.6%, 57.5%), with 18.4% in the RYGB group and 23.0% in the semaglutide group having a diagnosis of T2D. The pre-intervention BMI was 43.1 kg/m^2 and 43.2 kg/m^2 and the %TWL from pre-SG to pre-intervention was 9.6% and 9.5% respectively. The average length of time between the LSG and intervention was 4.9 years for the RYGB group and 4.7 years for the semaglutide group. While all patients met criteria by their weight for surgical re-intervention, based on clinic notes and operative notes, 48.3% of our patients (n = 42) also had an indication of GERD for their conversion to RYGB.

Due to the retrospective nature of the study, patient semaglutide use was not uniform, reflecting barriers to access, impact of side effect, and individual clinical needs. The average length of time patients were treated with semaglutide was 1.97 ± 1.40 years (Supplemental Table 3). Twenty-six patients stopped taking semaglutide less than one year after

Table 1 Overall patient demographic information

	RYGB ($N = 87$)	Semaglutide ($N = 87$)	p-value
Age at intervention			
Mean (SD)	41.8 (10.4)	43.6 (9.68)	0.255
Gender			
Female	79 (90.8%)	79 (90.8%)	1.00
Male	8 (9.2%)	8 (9.2%)	
Race			
White	58 (66.7%)	62 (71.3%)	0.620
Black	9 (10.3%)	10 (11.5%)	
Other	15 (17.2%)	9 (10.3%)	
Unknown	5 (5.7%)	6 (6.9%)	
Ethnicity			
Non-Hispanic	66 (75.9%)	71 (81.6%)	0.639
Hispanic	20 (23.0%)	15 (17.2%)	
Not Disclosed	1 (1.1%)	1 (1.1%)	
Diabetes Status			
None	51 (58.6%)	50 (57.5%)	0.706
Pre-Diabetes	20 (23.0%)	17 (19.5%)	
Diabetes	16 (18.4%)	20 (23.0%)	
Pre-Intervention BMI (kg/m^2)			
Mean (SD)	43.1 (6.40)	43.2 (7.66)	0.965
Pre-Intervention %TWL			
Mean (SD)	9.56 (9.50)	9.51 (9.15)	0.971
Interval (years)			
Mean (SD)	4.90 (2.77)	4.71 (2.59)	0.652

Each cohort contained 87 patients (total $N = 174$)

Gender, race and ethnicity were self-identified by patients and obtained from the medical record

Continuous variables represented as mean (SD), with significance calculated using t test

Categorial variables represented as absolute numbers (percent of column total), with significance calculated using chi-squared analysis

Significance set to $p < 0.05$

starting the medication (10 followed with tirzepatide during the two-year follow-up), and 20 patients stopped the medication between one to two years after starting the medication (15 transitioned to tirzepatide during the 2-year follow-up). For patients remaining on semaglutide at these times, the average dose at one year was 1.86 ± 0.71 mg per week and at two years was 1.96 ± 0.68 mg per week. Of the patients with two-year follow-up data (56 patients), 35 patients (62.5%) remained on semaglutide and eight patients were on tirzepatide (14.2%), for a total of 43 (76.8%) patients remaining on medication.

Overall weight loss

We observed superior weight loss in the RYGB versus semaglutide cohorts at every timepoint following intervention for RWG (Fig. 2). Two years following conversion to RYGB or initiation of postoperative semaglutide, the %TWL ± SD from the time of intervention was 17.1 ± 8.1% and 7.6 ± 13.6% respectively (mean difference = 9.5%, 95% CI [2.6, 16.4], $p = 0.002$, Fig. 2A). Additionally, we observed similar weight loss outcomes between the RYGB and semaglutide cohorts when normalizing %TWL to their weight prior to the index SG, thus capturing the entire weight loss trajectory. These trends are further re-demonstrated through comparison of BMI change between the groups (Fig. 2C, D). Using a 10% TWL cutoff as a definition of an effective obesity intervention, at one-year post-intervention, 82.6% of RYGB patients met criteria (57 of 69 with data), but only 40.9% of semaglutide patients did (27 of 66 with data), demonstrating greater variability in patient response to medication ($p < 0.001$).

We next sought to examine whether weight loss following intervention for RWG is associated with the original effectiveness of the index SG (Fig. 3). There was no significant correlation between maximal sustained weight loss from SG to nadir and one-year %TWL outcomes following RYGB or semaglutide (Fig. 3A). Additionally, there was no significant

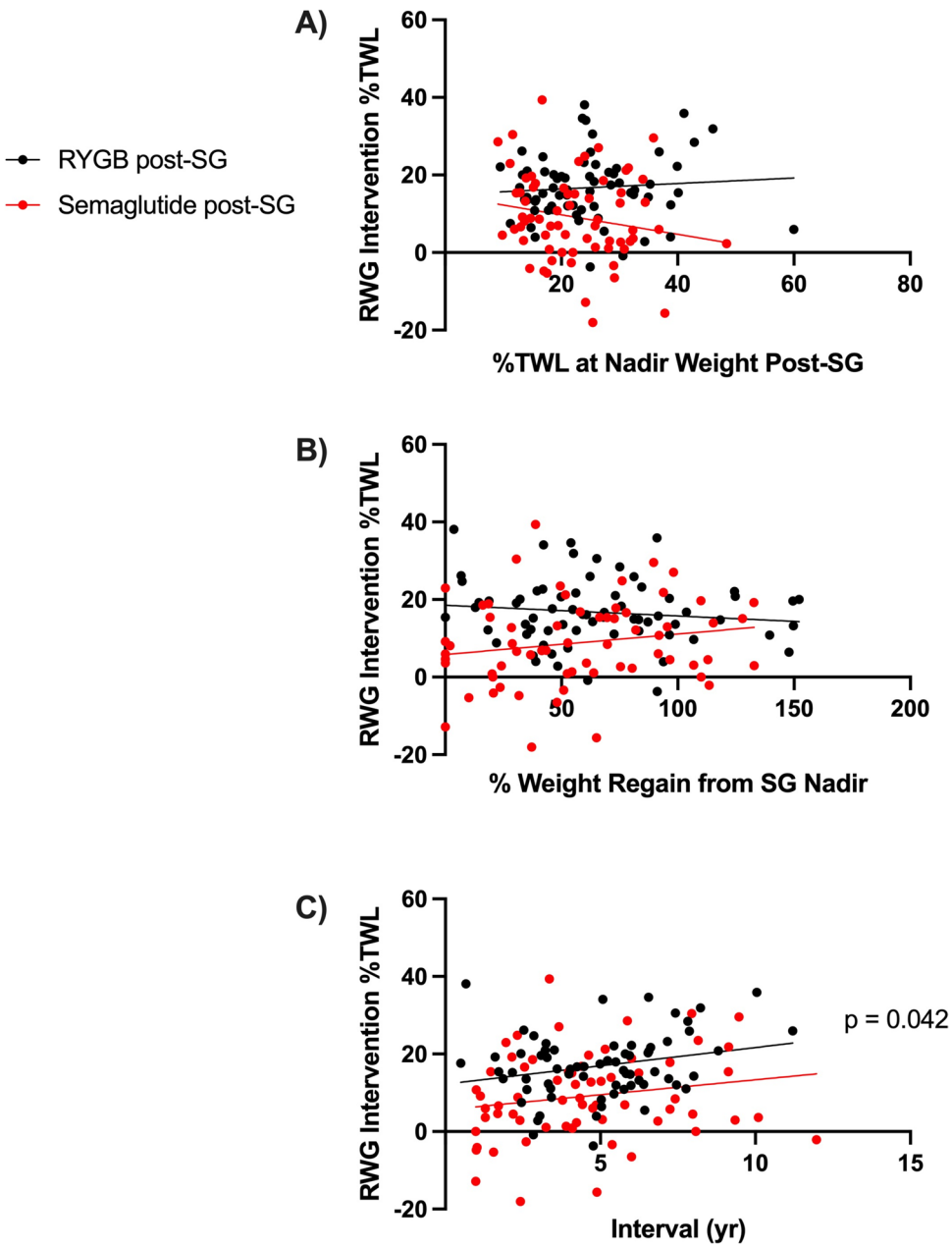


Fig. 3 Correlation between sleeve gastrectomy outcomes and intervention outcomes at one year. Each data point reflects an individual study patient (68 patients in the RYGB cohort, 66 in the semaglutide cohort, total N = 134). Best fit lines reflect linear regression. Correlation between one-year intervention %TWL and **A** SG nadir weight, **B** Weight regain from nadir, and **C** Interval between SG and intervention. Significance set to $p < 0.05$

association between the degree of RWG from SG nadir, and effectiveness of the intervention in either cohort (Fig. 3B). Finally, in the RYGB cohort, there was a positive association between intervention %TWL and the interval between SG and RWG intervention ($p = 0.042$). Thus, patients with a longer interval between SG and their RYGB for RWG were found to experience greater %TWL one year from the time of intervention (Fig. 3C).

Resolution of obesity comorbidities

For patients with T2D (16 in the RYGB cohort, 20 in the semaglutide cohort), there was no significant improvement in mean HbA_{1c} over time in either intervention group (change from 6.4% to 5.4% in RYGB patients, 6.9% to 6.6% in semaglutide patients, effect of time $p = 0.070$, effect of intervention $p = 0.144$). Analyzing each cohort individually from pre-intervention to one year post-intervention, the mean difference in HbA_{1c} was − 0.5 ± 0.1% ($n = 4$, 95% CI [− 0.7, − 0.3], $p = 0.006$) in the RYGB group, and − 0.8 ± 0.9% (n = 6, 95% CI [− 1.7, 0.1], $p = 0.08$) in the semaglutide cohort.

However, RYGB significantly reduced overall diabetes medication requirements compared to semaglutide: 43.8% and 5.3% had a decrease in diabetes medications ($p = 0.018$), 56.3% and 40.0% had no change ($p = 0.526$), and 0.0% and

55.0% had an increased requirement in the RYGB and semaglutide cohorts, respectively ($p = 0.001$). Three patients in the RYGB group were on insulin before RYGB, of which only one remained insulin-dependent two years post-intervention; four patients in the semaglutide group started on insulin, and all remained insulin-dependent. In the semaglutide cohort, semaglutide was counted as a diabetes medication with the interpretation that positive efficacy would allow patients to stop taking other diabetes medication.

Overall, there was no significant difference in the change in anti-hypertensive medications required by each group ($p = 0.709$). The majority of RYGB and semaglutide patients had no change in their anti-hypertensive requirements over the two-year follow-up period (82.8%, 80.5% respectively, $p = 0.845$), while 11.5% and 10.3% decreased their anti-hypertensive requirements ($p = 1.00$) and only 5.7% and 9.2% respectively had an increased requirement ($p = 0.564$).

Complications

Early, 30-day complications were similar in semaglutide and RYGB cohorts (Table 2). Patients had similar rates of 30-day ED visits (12.6% vs 6.9%, $p = 0.307$) and serious complications (Clavien-Dindo (CD) III (5.7% vs 1.1%, $p = 0.207$); CD IV complications (1.1% vs 0.0%, $p > 0.999$). There were no 30-day mortalities in either group.

At 2 year follow-up, the cohorts continued to have similar rates of ED visits (54.0% vs 46.0%, p = 0.363) and hospital admissions (39.1% vs 31.0%, $p = 0.340$). The percent of patients who underwent gastrointestinal operations in the RYGB and semaglutide cohorts was 18.4% and 4.6% at 2 years ($p = 0.025$; specific operations listed in Supplemental Fig. 2), with the majority of the difference being driven by a significantly increased rate of diagnostic/exploratory laparosopies and operations for internal hernia following RYGB. Cholecystectomies were not statistically different for RYGB or semaglutide (1.1%, 3.4%, $p = 0.613$). Endoscopic interventions were also more frequent in RYGB than semaglutide patients (6.9% vs. 0.0%, $p = 0.038$).

Gastrointestinal side effects were reported by 27.6% of semaglutide patients, with the most common being nausea, vomiting, and constipation (Supplemental Fig. 2). Nine patients (10.3%) reported that they stopped the medication because of side effects. There were no reported cases of pancreatitis in the semaglutide study group.

Semaglutide responder sub-group analysis

Consistent with previous studies, our patient cohort had wide variability in weight response after semaglutide therapy [29, 30]. To better understand how early variable response to semaglutide impacted longer-term weight outcomes, patients were stratified into 'responders' (≥ 5% TWL at 3 months, $n = 26$, 30% of cohort) or 'non-responders' (< 5% TWL at 3 months, $n = 61$, 70%). The average duration and dose of semaglutide use was similar in the responder and non-responder cohort (Supplemental Table 3). At the end of the 2 year follow-up, a minority of patients, similar in both sub-groups, transitioned to tirzapetide; however, more

Table 2 Complications and patient reported side effects within two years post-intervention

	RYGB ($N = 87$)	Semaglutide ($N = 87$)	p-value
30-Day Complications			
Emergency Department Visits	11 patients (13%)	6 patients (7%)	0.307
Clavien-Dindo II	-	-	
Clavien-Dindo III	5 patients (6%)	1 patient (1%)	0.207
Clavien-Dindo IV	1 patient (1%)	–	> 0.999
Clavien-Dindo V	–	–	
2-Year Complications			
Emergency Department Visits	47 patients (54%)	40 patients (46%)	0.363
Hospital Admissions	34 patients (39%)	27 patients (31%)	0.340
GI Surgical Interventions	14 patients (16%)	4 patients (5%)	**0.025**
Non-Plastic	10 patients (11%)	4 patients (5%)	0.164
Laparoscopies + Internal Hernia Repairs	8 patients (9%)	–	**0.011**
Plastic	5 patients (6%)	–	0.070
GI Endoscopic Interventions	6 patients (7%)	–	**0.038**

Absolute number of patients followed by percentage of all patients in the treatment cohort

30-day and 2-year ED visit, hospital admissions, severe complications, and operations for patients in both cohorts

Significance calculated with chi-square test with Yates correction

Significance set to $p < 0.05$

semaglutide non-responders (31%) were off all medication compared to the responders (15%).

%TWL for the semaglutide 'responders' at 2-years was 22.9 ± 8.6% compared to 17.1 ± 8.1% in the overall RYGB cohort (mean difference = 5.8%, 95% CI [− 4.1, 15.8], p = 0.423, Fig. 4B). However, semaglutide 'non-responders' had lower 2-year weight loss compared to the overall RYGB cohort (2.8 ± 11.2% and 17.1 ± 8.1%, respectively; mean difference = −14.3%, 95% CI [− 20.9, − 7.6], $p < 0.0001$, Fig. 4A). A cohort of RYGB that was propensity matched to the semaglutide 'responders' was created, and semaglutide responders again had statistically equivalent weight loss with the matched RYGB cohort (22.9 ± 8.6% vs. 14.5 ± 7.9%; mean difference = 8.4%, 95% CI [−2.2, 19.1], p = 0.169, Fig. 4C).

Discussion

This retrospective cohort study compared RYGB conversion and semaglutide for treatment of RWG after SG. RYGB conversion led to greater and more consistent two-year %TWL compared to semaglutide. Additionally, diabetes outcomes were better with RYGB conversion, with improved HbA1c control and more frequent in reduction of diabetes medications. Still, at one and two years, we found RYGB had only 16.8% and 17.1% TWL relative to pre-conversion weight. Even when accounting for weight loss from the index SG and RYGB conversion (average 23.9%TWL), these results are lower than the 25–30% TWL plateau expected with a primary RYGB [33, 34]. Our findings are consistent with previous multicenter and systematic review findings showing %TWL with RYGB conversion of 13.6–24.3% [16, 17, 31, 32]. Together, these data suggest that efficacy of RYGB conversion for SG RWG is less than primary RYGB, and that the population of patients who suffer RWG overall do less well than primary surgery patients.

Similarly, we observed a two-year 7.6% overall TWL with semaglutide, lower than what has been reported in non-surgical populations. The STEP trials found maximum-dose semaglutide therapy leads to an average of 12.6% greater TWL compared to placebo at two years [30]. However, real-world efficacy of semaglutide and other GLP-1 agonists is lower than what has been reported in trial and similar to what we observed in our study [44]. Outside of clinical trials, many patients struggle to maintain consistent treatment, as we saw in our study, due to access, cost, and side-effects of the medications. Compliance with treatment is a critical drawback of the GLP-1 medications, as clinical trials have also shown recurrence of weight if GLP-1 medications are stopped [45].

Nevertheless, patients remain wary of surgical conversion, perhaps due to fear of poor efficacy of repeat surgery and the risks of the revisional surgery. Unfortunately, both these concerns are supported by our data. Not only is overall efficacy of conversion RYGB lower than primary RYGB, but over 17% of patients achieved less than 10% TWL at one year. Further, while the overall safety profile was acceptable, with early complications comparable to semaglutide treatment, patients who underwent RYGB conversion did have higher longer term need for GI surgical and endoscopic reinterventions, driven by operations to treat or rule out internal hernia. Other SG revisional operations, such as single anastomosis duodenal switch, Biliopancreatic Diversion with Duodenal Switch, and long-limb RYGB, have been reported to be more efficacious than standard RYGB and merit future comparison to GLP-1 therapy [33, 39–43].

In an effort to better identify patients who would benefit from RYGB versus semaglutide, we performed subgroup analysis of semaglutide 'responders.' Using a cut-off of TWL of ≥ 5% at three-months post-initiation of semaglutide, we found that semaglutide responders had comparable two year weight outcomes as RYGB conversion. Importantly, only 30% of the overall semaglutide cohort met this minimum definition of 'responder,' highlighting the variability

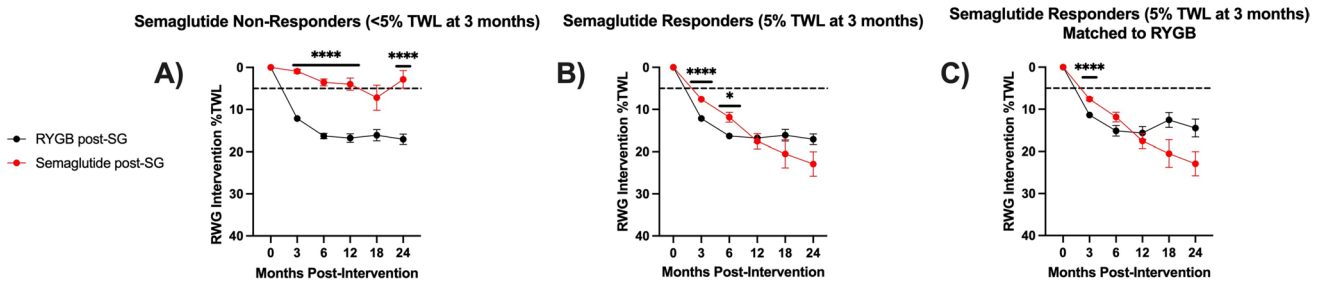


Fig. 4 Weight loss of semaglutide 'non-responders' and 'responders' through 2 years. **A** Non-Responders (< 5% TWL at 3 months) versus overall RYGB cohort. Responders (≥ 5% TWL at 3 months) versus, **B** overall RYGB cohort and **C** matched RYGB cohort. 2-year follow-up for RYGB and semaglutide cohorts: **A** n = 44 (56% of eligible patients) and n = 29 (71%), **B** n = 44 (56%) and n = 9 (60%), **C** n = 14 (64%) and n = 9 (60%)

of patient compliance and response to GLP-1 agonists demonstrated in multiple studies [19, 29, 30]. Moreover, semaglutide 'non-responders' lost significantly less weight at two years compared to the overall RYGB cohort, suggesting that those patients who do not respond to semaglutide by three months should consider surgical revision, rather than persisting with medical therapy.

Robust pre-treatment factors that predict semaglutide have yet to be identified [38]. Similarly, markers to identify RYGB responders are overall weak and sparse [46]. A recent study by Cuva et al. created the BE-CALM algorithm to predict %TWL at one year post-SG to RYGB conversion [35]. They identified higher index BMI, peak excess weight loss after SG of $\geq$40%, and weight regain $\leq$20% after SG as predictive of greater %TWL after conversion surgery. In our study, nadir weight after SG and weight regain from nadir did not impact RWG or SWL intervention weight outcomes; however, we saw a positive correlation between the length of time between the index SG and the RWG intervention for patients in the RYGB cohort. The small numbers in our study limit our power to detect predictors of response to SG RWG treatments and highlight the need for future research to identify pre-operative predictors of response to obesity treatment.

Our study has several limitations, primarily related to its single-center retrospective design. Despite a matching strategy to minimize confounders, uncaptured differences between our comparison groups may exist that could influence our findings. Additionally, patients in the semaglutide cohort did not all consistently stay on therapy, due to insurance coverage changes, medication shortages, and side effects. A minority of patients transitioned to tirzepatide, which limit our ability to completely isolate semaglutide efficacy for RWG. However, these issues reflect real-world challenges and efficacy of GLP-1 medications [44]. Our study was also underpowered to fully detect differences in obesity co-morbidity improvement. Finally, the BMI distribution of patients in our study was low, with only 12.1% of patients with a BMI $\geq$50 kg/m^2. The comparative efficacy and risks of RYGB and semaglutide for RWG may differ in patients at higher BMI.

Conclusion

In summary, we find that overall, RYGB conversion leads to greater and more consistent weight loss compared to semaglutide for RWG after SG. RYGB also leads to greater improvements in diabetes than semaglutide, although at the cost of more future surgical or endoscopic GI interventions. In patients who lose $\geq$5% TWL by three months after semaglutide initiation, weight loss outcomes are equivalent to RYGB conversion. Together, this work provides valuable new data to guide providers and patients in personalizing treatment of weight recurrence and suboptimal weight loss following SG.

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Declarations

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References

1. Lautenbach A, Wernecke M, Huber TB et al (2022) The potential of semaglutide once-weekly in patients without Type 2 diabetes with weight regain or insufficient weight loss after bariatric surgery-a retrospective analysis. Obes Surg 32:3280–3288. https://doi.org/10.1007/s11695-022-06211-9
2. Seeras K, Sankararaman S, Lopez PP (2024) Sleeve gastrectomy. In: StatPearls. Treasure Island, FL: StatPearls Publishing
3. Felsenreich DM, Langer FB, Prager G (2019) Weight loss and resolution of comorbidities after sleeve gastrectomy: a review of long-term results. Scand J Surg 108:3–9. https://doi.org/10.1177/1457496918798192
4. Salminen P et al (2022) Effect of laparoscopic sleeve gastrectomy vs Roux-en-Y gastric bypass on weight loss, comorbidities, and reflux at 10 years in adult patients with obesity: the SLEEVEPASS randomized clinical trial. JAMA Surg 157(8):656–666. https://pubmed.ncbi.nlm.nih.gov/35731535/. Accessed 12 May 2024
5. Clapp B, Wynn M, Martyn C et al (2018) Long term (7 or more years) outcomes of the sleeve gastrectomy: a meta-analysis. Surgery Obesity Related Dis 14:741–747. https://doi.org/10.1016/j.soard.2018.02.027
6. Lauti M, Kularatna M, Hill AG, MacCormick AD (2016) Weight regain following sleeve gastrectomy-a systematic review. Obes Surg 26:1326–1334. https://doi.org/10.1007/s11695-016-2152-x
7. El Ansari W, Elhag W (2021) Weight regain and insufficient weight loss after bariatric surgery: definitions, prevalence, mechanisms, predictors, prevention and management strategies, and knowledge gaps-a scoping review. Obes Surg 31:1755–1766. https://doi.org/10.1007/s11695-020-05160-5
8. Noria SF, Shelby RD, Atkins KD et al (2023) Weight regain after bariatric surgery: scope of the problem, causes, prevention, and treatment. Curr Diab Rep 23:31–42. https://doi.org/10.1007/s11892-023-01498-z
9. Haddad A, Suter M, Greve JW et al (2024) Therapeutic options for recurrence of weight and obesity related complications after metabolic and bariatric surgery: an IFSO position statement. Obes Surg 34:3944–3962. https://doi.org/10.1007/s11695-024-07489-7
10. Kraljevic M, Süsstrunk J, Wölnerhanssen BK et al (2025) Long-term outcomes of laparoscopic Roux-en-Y gastric bypass vs

laparoscopic sleeve gastrectomy for obesity: The SM-BOSS randomized clinical trial. JAMA Surg. https://doi.org/10.1001/jamasurg.2024.7052
11. Aliakbarian H, Bhutta HY, Heshmati K et al (2020) Preoperative predictors of weight loss and weight regain following Roux-en-Y gastric bypass surgery: a prospective human study. Obes Surg 30:4852–4859. https://doi.org/10.1007/s11695-020-04877-7
12. Salminen P, Kow L, Aminian A et al (2024) IFSO consensus on definitions and clinical practice guidelines for obesity management-an international delphi study. Obes Surg 34:30–42. https://doi.org/10.1007/s11695-023-06913-8
13. Dang JT, Vaughan T, Mocanu V et al (2023) Conversion of sleeve gastrectomy to Roux-en-Y gastric bypass: indications, prevalence, and safety. Obes Surg 33:1486–1493. https://doi.org/10.1007/s11695-023-06546-x
14. Brethauer SA, Kothari S, Sudan R et al (2014) Systematic review on reoperative bariatric surgery: American society for metabolic and bariatric surgery revision task force. Surg Obes Relat Dis 10:952–972. https://doi.org/10.1016/j.soard.2014.02.014
15. Roach E, Laplante S, Stogryn S et al (2023) Weight loss outcomes for patients undergoing conversion to Roux-en-Y-gastric bypass after sleeve gastrectomy. Surg Endosc 37:3208–3214. https://doi.org/10.1007/s00464-022-09506-1
16. Diaz Del Gobbo G, Mahmoud N, Barajas-Gamboa JS et al (2022) Conversion of sleeve gastrectomy to Roux-en-Y gastric bypass to enhance weight loss: single enterprise mid-term outcomes and literature review. Bariatr Surg Pract Patient Care 17:197–205. https://doi.org/10.1089/bari.2021.0096
17. Shen MR, Hammoud MM, Bonham AJ et al (2024) Conversion of sleeve gastrectomy to Roux-en-Y gastric bypass: impact on reflux and weight loss. Surg Obes Relat Dis 20:738–744. https://doi.org/10.1016/j.soard.2024.04.001
18. Çalık Başaran N, Dotan I, Dicker D (2024) Post metabolic bariatric surgery weight regain: the importance of GLP-1 levels. Int J Obes (Lond). https://doi.org/10.1038/s41366-024-01461-2
19. Mok J, Adeleke MO, Brown A et al (2023) Safety and efficacy of liraglutide, 3.0 mg, once daily vs placebo in patients with poor weight loss following metabolic surgery: the BARI-OPTIMISE randomized clinical trial. JAMA Surg 158:1003–1011. https://doi.org/10.1001/jamasurg.2023.2930
20. Rubino DM, Greenway FL, Khalid U et al (2022) Effect of weekly subcutaneous semaglutide vs daily liraglutide on body weight in adults with overweight or obesity without diabetes: The STEP 8 randomized clinical trial. JAMA 327:138–150. https://doi.org/10.1001/jama.2021.23619
21. Lautenbach A, Kantowski T, Wagner J et al (2023) Sustained weight loss with semaglutide once weekly in patients without type 2 diabetes and post-bariatric treatment failure. Clinical Obesity 13:e12593. https://doi.org/10.1111/cob.12593
22. Medhati P, Saleh OS, Nimeri A et al (2024) Outcomes and management of re-establishing bariatric patients. J Am Coll Surg 238:1035–1043. https://doi.org/10.1097/XCS.0000000000001062
23. American Diabetes Association Professional Practice Committee (2025) 8. Obesity and weight management for the prevention and treatment of type 2 diabetes: standards of care in diabetes-2025. Diabetes Care 48:S167–S180. https://doi.org/10.2337/dc25-S008
24. UnitedHealthcare (2024) Prior authorization/notification - plans with weight loss medication coverage. https://www.uhcprovider.com/content/dam/provider/docs/public/prior-auth/drugs-pharmacy/commercial/r-z/PA-Notification-Weight-Loss.pdf
25. Mass General Brigham (n.d.) Qualifying for surgery - surgical weight management. https://salem.massgeneralbrigham.org/weight_management/qualifying_for_surgery. Accessed 28 Feb 2025
26. Brigham and Women's Hospital (n.d.) Laparoscopic sleeve gastrectom. https://www.brighamandwomens.org/cwmw/gastric-bypass. Accessed 28 Feb 2025
27. Brethauer SA, Kim J, el Chaar M et al (2015) Standardized outcomes reporting in metabolic and bariatric surgery. Surg Obes Relat Dis 11:489–506. https://doi.org/10.1016/j.soard.2015.02.003
28. Jirapinyo P et al (2017) Weight regain after Roux-en-Y gastric bypass has a large negative impact on the Bariatric Quality of Life Index. BMJ Open Gastroenterology 4:e000153. https://bmjopengastro.bmj.com/content/4/1/e000153. Accessed 26 Jan 2025
29. Mosenzon O, Garvey WT, Hesse D et al (2021) Clinically-relevant weight loss is achieved independently of early weight loss response to once-weekly subcutaneous semaglutide 2.4 MG (STEP 4). J Endocr Soc 5:A7. https://doi.org/10.1210/jendso/bvab048.013
30. Garvey WT, Batterham RL, Bhatta M et al (2022) Two-year effects of semaglutide in adults with overweight or obesity: the STEP 5 trial. Nat Med 28:2083–2091. https://doi.org/10.1038/s41591-022-02026-4
31. Fehervari M, Banh S, Varma P et al (2023) Weight loss specific to indication, remission of diabetes, and short-term complications after sleeve gastrectomy conversion to Roux-en-Y gastric bypass: a systematic review and meta-analysis. Surg Obes Relat Dis 19:384–395. https://doi.org/10.1016/j.soard.2022.11.004
32. Pina L, Parker DM, Wood GC et al (2024) Laparoscopic sleeve gastrectomy conversion to gastric bypass: conversion rate over time, predictors of conversion, and weight loss outcomes. Surg Obes Relat Dis 20:462–466. https://doi.org/10.1016/j.soard.2023.11.018
33. Salte OBK, Olbers T, Risstad H et al (2024) Ten-year outcomes following Roux-en-Y gastric bypass vs duodenal switch for high body mass index: a randomized clinical trial. JAMA Netw Open 7:e2414340. https://doi.org/10.1001/jamanetworkopen.2024.14340
34. Maciejewski ML, Arterburn DE, Van Scoyoc L et al (2016) Bariatric surgery and long-term durability of weight loss. JAMA Surg 151:1046–1055. https://doi.org/10.1001/jamasurg.2016.2317
35. Cuva D, Parikh M, Brown A et al (2024) BE-CALM: a clinical score to predict weight loss after conversion from sleeve gastrectomy to Roux-en-Y gastric bypass. Surg Endosc. https://doi.org/10.1007/s00464-024-11460-z
38. Strathe A, Horn DB, Larsen MS et al (2023) A model-based approach to predict individual weight loss with semaglutide in people with overweight or obesity. Diabetes Obes Metab 25:3171–3180. https://doi.org/10.1111/dom.15211
39. Hage K, Teixeira AF, Surve A et al (2024) Single anastomosis duodenal switch versus Roux-en-Y gastric bypass in patients with BMI $\geq$ 50 kg/m2: a multi-centered comparative analysis. Surg Endosc 38:2657–2665. https://doi.org/10.1007/s00464-024-10765-3
40. Jamal M, Alhashemi M, Dsouza C et al (2024) Semaglutide and tirzepatide for the management of weight recurrence after sleeve gastrectomy: a retrospective cohort study. Obes Surg 34:1324–1332. https://doi.org/10.1007/s11695-024-07137-0
41. Frías JP, Davies MJ, Rosenstock J et al (2021) Tirzepatide versus semaglutide once weekly in patients with Type 2 diabetes. N Engl J Med 385:503–515. https://doi.org/10.1056/NEJMoa2107519
42. Möller F, Hedberg J, Skogar M, Sundbom M (2023) Long-term follow-up 15 years after duodenal switch or gastric bypass for super obesity: a randomized controlled trial. Obes Surg 33:2981–2990. https://doi.org/10.1007/s11695-023-06767-0
43. Rodriguez PJ, Goodwin Cartwright BM, Gratzl S et al (2024) Semaglutide vs tirzepatide for weight loss in adults with overweight or obesity. JAMA Intern Med 184:1056–1064. https://doi.org/10.1001/jamainternmed.2024.2525

44. Medhati P, Shin TH, Wasden K, Mathur V et al (2025) GLP-1RA in the real world: 1-year compliance and outcomes of semaglutide use in patients with or without previous history of bariatric surgery. Ann Surg. https://doi.org/10.1097/SLA.0000000000006748
45. Rubino D, Abrahamsson N, Davies M, Hesse D, Greenway FL, Jensen C, Lingvay I, Mosenzon O, Rosenstock J, Rubio MA, Rudofsky G, Tadayon S, Wadden TA, Dicker D, STEP 4 Investigators (2021) Effect of continued weekly subcutaneous semaglutide vs placebo on weight loss maintenance in adults with overweight or obesity: the STEP 4 randomized clinical trial. JAMA 325(14):1414–1425. https://doi.org/10.1001/jama.2021.3224
46. Aliakbarian H, Bhutta HY, Heshmati K, Unes Kunju S, Sheu EG, Tavakkoli A (2020) Pre-operative predictors of weight loss and weight regain following Roux-en-Y gastric bypass surgery: a prospective human study. Obes Surg 30(12):4852–4859. https://doi.org/10.1007/s11695-020-04877-7