BARIATRIC SURGICAL PRACTICE AND PATIENT CARE
Volume 18, Number 1, 2023

DOI: 10.1089/bari.2021.0117

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Preoperative Weight Loss as a Predictor of Short and Midterm Postoperative Weight Loss in Patients Undergoing Bariatric Surgery

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Objective: To examine if preoperative weight loss correlates to postoperative weight loss 2 and 3 years after surgery.
Methods: A review was conducted of bariatric surgery patients who underwent either gastric bypass or sleeve gastrectomy during 2015–2018 and had 3-year follow-up data. Demographic and outcome data were collected. A best-fit regression model for weight loss was constructed.
Results: Eight hundred fifty-nine patients underwent surgery during the selected period, of which 199 patients (23%) were analyzed. Eighty-two percent of patients had gastric bypass and 82% were female. Preoperative percent excess weight loss (%EWL) was not significantly associated with 2- and 3-year postoperative %EWL ($p = 0.18$). Patients demonstrated significant weight regain at 3 years postoperatively versus 1 year ($p < 0.01$). Higher preoperative weight loss was associated with lower %EWL 3 years postoperatively versus 1 year ($p = 0.04$). Postoperative %EWL had a significant negative association with higher preoperative weight, diabetes, baseline use of a mobility device, and sleeve gastrectomy.
Conclusions: In a cohort of bariatric surgery patients, there was no statistically significant association between preoperative and midterm postoperative %EWL. Postoperative %EWL was negatively associated with several patient-specific factors and increasing time since operation.

Keywords: bariatric surgery, weight loss, sleeve gastrectomy, gastric bypass, insurance

Introduction

The value of a period of preoperative, medical weight loss before bariatric surgery is debated.[1,2] Preoperative weight loss before bariatric surgery may have beneficial effects, including decreased overall perioperative morbidity and mortality.[3,4] Some studies have suggested that preoperative weight loss may also predict postoperative weight loss.[2] However, the relationship between preoperative and postoperative weight loss has not been consistently demonstrated, and factors such as preoperative body mass index (BMI) may act as a mediating variable between preoperative and postoperative weight loss.[5] One systematic review identified 10 out of 17 studies that demonstrated no association between preoperative weight loss and postoperative weight loss, and found that most data on the subject were of middling to low quality.[6] Despite the lack of robust data demonstrating a significant relationship between preoperative weight loss and postoperative outcomes, some insurers continue to require patients to lose a specific amount of weight before undergoing bariatric surgery, which can delay or impede patient access to bariatric surgery and its health benefits.[7]

To date, most investigations of the relationship between preoperative and postoperative weight loss have examined only 12-month postoperative weight loss. Most patients who undergo bariatric surgery regain weight after their first

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postoperative year, which calls into question what relationship this weight regain might have with preoperative weight loss. Midterm weight loss after bariatric surgery has been shown to be associated with socioeconomic factors.[8] However, the association between preoperative and midterm postoperative weight loss has not been examined. Our intent with this study was to determine whether preoperative weight loss correlates to postoperative weight loss 3 years after surgery.

Materials and Methods

We conducted a retrospective chart review at a large, academic medical center with a high-volume bariatric practice. The study was submitted for review and was approved by the Institutional Review Board before data collection and analysis. Data were gleaned from our institutional Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) database with additional review of records using the institutional electronic medical record. Included patients were all those who underwent index laparoscopic sleeve gastrectomy (LSG) or laparoscopic Roux-en-Y gastric bypass (LRYGB) from January 1, 2015 to December 31, 2018 and who had 3-year follow-up data available. The time period was chosen from the advent of a high-volume, multidisciplinary metabolic surgery program and extended to include all patients with possible 3-year follow-up data. Patients undergoing revisional bariatric surgery were not included. In this practice, patients are requested to keep yearly postoperative follow-up visits.

Data collected included demographics, comorbidities, surgical data, and preoperative and postoperative weights at 1, 2, and 3 years after surgery. Standard calculations for BMI and percent weight loss variables were used, with ''excess weight'' corresponding to the difference between the patient's current weight and the patient's weight if that person's BMI was 25 kg/m^2. Preoperative weight loss was defined as the patient's weight on the day of their index surgery subtracted from their weight on the day of their first preoperative visit. Postoperative weight loss was defined as the patient's weight at a specific postoperative time point subtracted from their weight on the day of their index surgery.

Demographic information included sex, race, ethnicity, and age in years at the time of surgery. Medical comorbidities included: diabetes; tobacco use; functional status (independent or dependent for activities of daily living); chronic obstructive pulmonary disease and oxygen dependence; prior venous thromboembolism or inferior vena cava filter placement; venous stasis disease; obstructive sleep apnea; use of a mobility device; gastroesophageal reflux disease (GERD); prior cardiac event, surgery, or catheterization; hypertension requiring at least one medication (HTN); hyperlipidemia; renal disease or dialysis; steroid or anticoagulant use; prior organ transplantation.

All analyses were conducted in SAS 9.4 (SAS Institute, Inc., Cary, NC). Missing data points were excluded from analysis. Valid percentages and frequencies were calculated for categorical variables, and means, standard deviations (SDs), and ranges were given for continuous variables. The primary research question was analyzed with a variety of repeated and random effects linear mixed models with restricted maximum likelihood (REML) estimation and the Kenward–Roger degree of freedom method. A best-fitting model was decided by lowest Akaike information criterion (AIC), and included time added categorically as a repeated measure with an autoregressive covariance structure. Model assumptions were checked and found satisfactory. Sensitivity analyses were conducted to check consistency across all weight outcomes and by attrition (e.g., complete case analysis).

A sensitivity analysis was conducted, examining model differences between those with complete weight data across all time points ($n = 152$), and the results when all participants ($n = 199$) were included using the REML estimation method in the linear mixed model. No differences were noted between these models, so the models with all cases are presented. Additional sensitivity analysis included models with different methods of calculating weight loss, including percent BMI loss and percent total body weight loss. No significant differences were noted, so only percent excess weight loss (%EWL) is presented in this study as it presented with the best model AIC.

Results

Eight hundred fifty-nine patients underwent index sleeve gastrectomy or gastric bypass during the selected time period. One hundred ninety-nine (23%) patients had 3-year follow-up data available. One individual was an extreme outlier on preoperative weight loss (gaining 55 kg before their operation) and was dropped from all analyses, which left 198 patients that had 3-year follow-up data and were included in analysis. Of these, 179 (90%) had 1-year follow-up data, and 163 (82%) had 2-year data. Eighty-two percent of patients had gastric bypass, 97% were white, and 82% were female (Tables 1 and 2). Average age was 47 years (SD = 11.3 years). The most common medical comorbid conditions included

Table 1. Descriptive Statistics, Continuous Variables

Variable	*Mean*	*Standard deviation*
Age, years	47.31	11.28
Preop hematocrit, %	41.3	3.6
Preop albumin, g/dL	3.85	0.34
%EWL		
Preop from initial	11.71	11.08
12 months from preop	68.14	24.96
24 months from preop	63.64	28.22
36 months from preop	58.32	28.86
%TWL		
Preop from initial	5.53	5.03
12 months from preop	28.62	9.47
24 months from preop	27.06	11.98
36 months from preop	24.53	11.93
BMI		
Initial	47.49	7.45
Preop	44.75	6.71
12 months	31.88	5.93
24 months	32.59	6.37
36 months	33.62	6.71

BMI, body mass index; %EWL, percent excess weight loss; %TWL, percent total weight loss.

Table 2. Descriptive Statistics, Categorical Variables

Category	*Number of patients*	*%*
Procedure		
Gastric bypass	163	82.3
Sleeve gastrectomy	35	17.7
Race		
White	190	96.5
Other	7	3.6
Sex		
Male	35	17.7
Female	163	82.3
Ethnicity		
Non-Hispanic	193	99
Hispanic	2	1
Diabetes		
No	126	64
Yes, no insulin	35	17.8
Yes, with insulin	36	18.3
Smoker	13	6.6
COPD	3	1.5
Oxygen dependent	7	3.5
Sleep apnea	83	42
Mobility device	7	3.5
GERD	976	48.5
Previous surgery	7	3.5
Prior cardiac surgery	8	4
Prior percutaneous coronary intervention	3	1.5
Prior myocardial infarct	7	3.5
Hyperlipidemia	74	37.4
Renal insufficiency	2	1
Dialysis	1	0.5
Steroid use	4	2
History of DVT	4	2
History of pulmonary embolism	1	0.5
Anticoagulation	7	3.5
HTN requiring medications	127	64.1
Number of HTN meds		
0	71	35.9
1	43	21.7
2	46	23.2
3	28	14.1
4	4	2
5	4	2
6	1	0.5
7	1	0.5
ASA class		
2	33	16.7
3	158	79.8
4	7	3.5

ASA, American Society of Anesthesiologists; COPD, chronic obstructive pulmonary disease; DVT, deep vein thrombosis; GERD, gastroesophageal reflux disease; HTN, hypertension requiring at least one medication.

HTN (64%), GERD (49%), sleep apnea (42%), hyperlipidemia (37%), and diabetes (36%). Four percent used a mobility device at baseline. Most patients were American Society of Anesthesiologists class 3 (80%).

On average, participants lost a small amount of weight preoperatively (mean = 7.7 kg, SD = 7.3). All participants lost weight by the 12-month follow-up (mean = 35.6 kg, SD = 13.6, minimum value 6.2 kg), although mean weight was slightly higher in subsequent years (mean = 30.5 kg at 3-year).

Table 3 presents the best-fitting model, examining %EWL postsurgery with predictors that include our primary predictors of interest (preoperative %EWL, time, and the interaction of %EWL and time) and covariates selected based on bivariate and model statistical significance. Factors associated with reduced %EWL include: higher initial weight ($p < 0.01$); diabetes both with and without insulin dependence ($p < 0.01$ for both), baseline use of a mobility device ($p = 0.02$); and having a sleeve gastrectomy relative to having gastric bypass ($p < 0.01$). After controlling for the covariates, preoperative %EWL was positively associated with postsurgery %EWL, although the variable did not reach statistical significance ($p = 0.18$). Time was associated with reduced postsurgery %EWL at the 3-year mark relative to the 1-year mark ($p < 0.01$). Presurgery %EWL was associated with reduced postsurgery %EWL at the 3-year mark relative to the 1-year mark ($p = 0.04$).

Discussion

In this study, we used retrospective chart review to examine the relationship between preoperative weight loss and 3-year postoperative weight loss. Weight loss and patient-specific factors were examined using advanced regression techniques. Analysis found no significant relationship between preoperative and postoperative weight loss. Reduced postoperative weight loss was associated with several patient-specific factors, including both insulin-dependent and

Table 3. Coefficients of Final Model

Variable	*Estimate*	*Standard error*	p
Intercept	150.73	18.58	<0.0001
Baseline weight, kg	−0.33	0.07	<0.0001
Diabetes			
No	0 (ref)		
Yes, no insulin	−12.08	3.9	0.002
Yes, with insulin	−16.08	4.01	<0.0001
ASA class			
2	0 (ref)		
3	−6.76	4.11	0.1
4	10.61	9.42	0.26
Mobility device	−20.05	8.13	0.015
Preop hematocrit (per %)	−0.64	0.41	0.12
LSG (vs. LRYGB)	−29.2	3.79	<0.0001
Preop %EWL	0.34	0.25	0.18
Time			
Year 1	0 (ref)		
Year 2	−3.66	2.1	0.08
Year 3	−6.72	1.53	<0.0001
Preop %EWL × time			
Year 1	0 (ref)		
Year 2	0.07	0.19	0.72
Year 3	−0.29	0.14	0.04

LRYGB, laparoscopic Roux-en-Y gastric bypass; LSG, laparoscopic sleeve gastrectomy.

noninsulin-dependent diabetes, baseline use of a mobility device, receipt of a gastric sleeve as opposed to a gastric bypass, and increasing time since surgery. Use of a covariate that combined both preoperative weight loss and time since surgery found that patients who demonstrated higher preoperative weight loss had more weight regain at 3 years relative to patients who lost less weight before surgery.

Other patient-specific factors that were found to negatively impact postoperative weight loss were, for the most part, anticipated results. It is well documented that the gastric sleeve leads to lower excess body weight loss than gastric bypass; increasing time since surgery has been known to be associated with weight regain for some time; comorbidity burden has been consistently implicated as negative predictor of weight loss in prior literature; and baseline use of a mobility device as a negative predictor for postoperative weight loss is intuitive, although in our study this result is limited by a low number of patients.[9]

The primary outcome in our study showed no significant association between preoperative weight loss and 3-year postoperative weight loss. This does call into question the necessity of a mandated period of medical weight loss before bariatric surgery. These findings are similar to other literature suggesting that insurer mandate for a specific amount of weight loss before surgery does not lead to improved weight loss and ultimately may hinder patient access to bariatric surgery.[10–12]

Prior studies have linked preoperative weight loss to a number of beneficial effects. These include a decrease in postoperative complications and mortality, a decrease in operating time, and shorter length of stay.[2–5] Hypothesized reasons for this relation include metabolic effects of weight loss, as well as a decreased intra-abdominal obesity that might make intra-abdominal anatomy easier to manipulate. However, associations between preoperative weight loss and morbidity and mortality, much like links to postoperative weight loss, have not been consistently shown.[7] In addition, insurer-mandated diets and weight loss periods may lead to treatment delay and inferior outcomes.[13,14] With regard to weight, while some studies have found a link between preoperative and postoperative weight loss, this link has been inconsistent and may be due to mediating variables.[5,6] Given the inconsistency of the overall body of evidence regarding mandatory weight loss programs before bariatric surgery, the ASMBS elected to take a firm stance against insurer mandates in 2016, finding that mandates were ''discriminatory, arbitrary, and scientifically unfounded…''[15]

Most patients in this study (82%) underwent LRYGB. This may be due to including 3-year follow-up data in our inclusion criteria, as the total number of patients undergoing LRYGB and LSG during the study period were 326 and 595, respectively. The high prevalence of patients undergoing LRYGB in this study may have biased the study, as these patients are known to undergo greater weight loss than patients undergoing LSG, and it may limit the clinical applicability of the results.

The primary limitation of this study is a low postoperative follow-up rate of 23%. Because the primary outcome was weight loss at 3 years, inclusion criteria were tailored to include only those with 3-year data. The lack of follow-up may have affected outcomes in other ways, as patients who complete follow-up visits have been shown to have superior weight loss outcomes compared with those who miss visits.[16] Thus those lost to follow-up likely had inferior weight loss outcomes.

The lack of long-term follow-up that is endemic in bariatric practices demonstrates a major system issue within the American bariatric surgical community. MBSAQIP does provide a large bariatric surgery dataset for public use, which has recently been utilized to study the effects of preoperative weight loss among large cohorts of bariatric surgery patients.[4,7] However, these data capture only 30-day outcomes due to quality issues with longer-term follow-up data. The lack of consistent mid- and long-term follow-up limits our understanding of how metabolic surgery impacts years after surgery.[17]

The study is also limited by its retrospective nature, the drawbacks of which are well known. Unfortunately, we anticipate that collecting high-quality data on postoperative bariatric surgery patients over the mid and long term will be challenging in the United States, where no universal medical record exists, and health care data are fragmented. The American surgical community may need to rely on its European peers' more thorough medical records to better shed light on which factors predict long-term success for patients who have undergone bariatric surgery.

Conclusion

We combined retrospective chart review with sophisticated regression modeling in a cohort of patients who underwent sleeve gastrectomy or gastric bypass from January 1, 2015 to December 31, 2018. There was no statistically significant association between preoperative and postoperative weight loss. Lower postoperative weight loss was associated with several patient-specific factors, most notably higher preoperative weight, diabetes, use of a mobility device, and increasing time since surgery. Patients with higher preoperative weight loss less sustained weight loss at 3 years than patients with lower preoperative weight loss. These conclusions are limited by the retrospective nature of the study, as well as low 3-year follow-up.

Study Importance

- A trial of preoperative weight loss before bariatric surgery is often required by insurance companies
- The effect of preoperative weight loss on postoperative weight loss has conflicting data
- There was no significant association between preoperative weight loss and 3-year, postoperative weight loss in this study
- Higher preoperative weight loss was associated with higher proportional weight regain at 3 years versus 1 year postoperatively
- The results of this study lend additional evidence to the position of the ASMBS against insurer-mandated preoperative weight loss trials
- The results of this study point out a deficit of long-term follow-up data in U.S. health care institutions

Disclosure Statement

N.L.S.: Founder Endolumik, Consultant CSATS, Consultant CMR Surgical, Industry Sponsored Research Digbi-Health. No other authors have pertinent financial disclosures.

Funding Information

Research reported in this publication was supported by the National Institute of General Medical Sciences of the National Institutes of Health under award number 5U54GM104942-05 through the West Virginia Clinical and Translational Science Institute. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

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