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The utility of weight loss medications after bariatric surgery for weight regain or inadequate weight loss: A multi-center study

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Abstract

Background: Patients who undergo bariatric surgery often have inadequate weight loss or weight regain.

Objectives: We sought to discern the utility of weight loss pharmacotherapy as an adjunct to bariatric surgery in patients with inadequate weight loss or weight regain.

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Disclosures

The authors have no commercial associations that might be a conflict of interest in relation to this article.

Appendix

Supplementary data

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.soard.2016.10.018.

Setting: Two academic medical centers.

Methods: We completed a retrospective study to identify patients who had undergone bariatric surgery in the form of a Roux-en-Y gastric bypass (RYGB) or a sleeve gastrectomy from 2000–2014. From this cohort, we identified patients who were placed on weight loss pharmacotherapy postoperatively for inadequate weight loss or weight regain. We extracted key demographic data, medical history, and examined weight loss in response to surgery and after the initiation of weight loss pharmacotherapy.

Results: A total of 319 patients (RYGB = 258; sleeve gastrectomy =61) met inclusion criteria for analysis. More than half (54%; n = 172) of all study patients lost ≥5% (7.2 to 195.2 lbs) of their total weight with medications after surgery. There were several high responders with 30.3% of patients (n = 96) and 15% (n = 49) losing ≥10% (16.7 to 195.2 lbs) and ≥15% (25 to 195.2 lbs) of their total weight, respectively, Topiramate was the only medication that demonstrated a statistically significant response for weight loss with patients being twice as likely to lose at least 10% of their weight when placed on this medication (odds ratio 1.9; P .018). Regardless of the postoperative body mass index, patients who underwent RYGB were significantly more likely to lose ≥5% of their total weight with the aid of weight loss medications.

Conclusions: Weight loss pharmacotherapy serves as a useful adjunct to bariatric surgery in patients with inadequate weight loss or weight regain. (Surg Obes Relat Dis 2017;13:491–501.)

Keywords

Obesity; Bariatric surgery; Weight regain; Inadequate weight loss; Obesity co-morbidities

Obesity is the most prevalent chronic disease in the United States. Over 91 million children and adults meet criteria for obesity denoted by a body mass index (BMI) at or above the 95th percentile of the sex-specific U.S. Centers for Disease Control and Prevention BMI-for-age growth charts for children and adolescents (aged 2- to 20-years-old) and a BMI ≥30 kg/m^2 in adults [1]. Due to the pronounced disease burden, linkage to several co-morbidities including type 2 diabetes, hypertension, obstructive sleep apnea (OSA), nonalcoholic fatty liver disease (NAFLD), several cancers, a host of other diseases, and its subsequent impact on quality of life, morbidity, and mortality, there is a need for both prevention and treatment [2].

To date, bariatric surgery has been the most effective treatment for persons with moderate (BMI 35–39.9) and severe obesity (BMI ≥40) [3–5]. Patients often experience complete resolution or improvement of obesity related comorbidities, and there is a dramatic reduction in healthcare costs [6]. Unfortunately, there is often inadequate weight loss or weight regain after bariatric surgery, and inadequate weight loss is generally defined as an initial loss of <50% of excess weight loss (EWL) in bariatric surgery [7,8].

Weight regain is multifactorial and categorized as patient specific (i.e., psychiatric, physical inactivity, endocrinopathies/metabolic, genetic, gender, race/ethnicity, and dietary noncompliance) and operation specific [9–18]. Concomitantly, there is often a reemergence of co-morbidities that initially improved after bariatric surgery [19,20]. While revisional bariatric surgery has been employed in this patient population [21], these often fail, require

reoperation, and are associated with complications [22–24]. Endoscopic pouch plications, stoma reductions, and sclerotherapy have been utilized to treat inadequate weight loss and weight regain in bariatric surgery patients [25,26], but this too has proven ineffective long term [27,28].

Studies that have been conducted in the bariatric surgery population show that significant weight regain (≥ 15% gain of initial weight loss postbariatric surgery) occurs in 25%–35% of persons who undergo surgery 2–5 years after their initial surgical date [18,29,30]. There have been a few small studies (< 15 patients) conducted on patients who have undergone bariatric surgery that demonstrate the utility of weight loss medications for inadequate weight loss or weight regain [18,27], but this practice has been subjected to minimal investigation at this time. In our present study, we performed a retrospective analysis to discern the utility of weight loss medications as an adjunct to bariatric surgery. To our knowledge, our multicenter study is the largest study to date to investigate this practice. Since weight regain and inadequate weight loss are common in patients who undergo bariatric surgery, there is a need for a range of therapeutic options to treat this patient population. We hypothesize that weight loss medications are a useful tool to confer additional weight loss after weight loss surgery. We seek to determine the utility of weight loss medications and determine which medication(s) has/have the highest efficacy after weight loss surgery.

Methods

Study sample and data collection

Our study sample consisted of patients who had undergone a Roux-en-Y gastric bypass (RYGB) or sleeve gastrectomy (SG) from November 2000 to June 2014 at 2 academic centers and received subsequent weight loss medications. All patients who underwent the aforementioned procedures and were placed on medication were considered. Eligible patients had a primary weight loss surgery at 2 major academic medical centers with at least 12 months of documented postoperative follow up. Patients were excluded if they underwent surgery for complications within 6 months of their primary weight loss surgery, had a revision surgery, or had insufficient follow up. The clinical data was extracted from the medical record by 2 research groups. The institutional review boards at both academic centers approved the study.

Measures

Demographic and clinical factors.—We extracted the following data from the patient record: 1) type of surgery (RYGB or SG); 2) date of operation; 3) date of birth; 4) gender; 5) race/ethnicity (Caucasian, Hispanic, black, Asian, or other); 6) preoperative obesity co-morbidities (hypertension, type 2 diabetes, OSA, dyslipidemia, and NAFLD); 7) preoperative use of weight loss medications; 8) BMI (based on initial height and weight at the following time points: presurgery, at plateau postsurgery, at the start of weight loss medication, at plateau postweight loss medication, and current; 9) time to achieve plateau weight postsurgery; 10) postoperative resolution of obesity comorbidities; 11) continued use of weight loss medication(s); 12) psychiatric co-morbidity (anxiety, depression, bipolar

disorder); 13) use of psychotropic medications presurgery; and 14) use of psychotropic medications postsurgery.

Weight loss medications.—We evaluated 15 medications that are prescribed by obesity medicine physicians within our centers, which include: 1) phentermine, 2) topiramate, 3) zonisamide, 4) metformin, 5) bupropion, 6) orlistat, 7) sibutramine, 8) liraglutide, 9) exenatide, 10) pramlinitide,11) naltrexone, 12) lorcaserin, 13) phentermine/topiramate,14) canagliflozin, and 15) bupropion/naltrexone. Of the medications evaluated, some have received U.S. Food and Drug Administration approval for short-term (i.e., phenter-mine) or long-term use (i.e., phentermine/topiramate, lorcaserin, bupropion/naltrexone, liraglutide, and orlistat) for weight loss while others were used off-label (i.e., topiramate, zonisamide, metformin, bupropion, exenatide, pramlinitide, naltrexone, and canagliflozin). While sibutramine was withdrawn from the market in October 2010, we included this drug in our study as its approval corresponded with a portion of our study period.

Lifestyle factors.—All patients who were prescribed medications in this retrospective study were encouraged to engage in healthy lifestyle behaviors such as consuming foods with high nutritional value, complying with postoperative vitamin and mineral supplementation, and engaging in purposeful physical activity as recommended in the 2013 American Association of Clinical Endocrinologists, The Obesity Society, and the American Society for Metabolic and Bariatric Surgery guidelines [31].

Primary endpoints.—Four coprimary endpoints were evaluated at the weight plateau after medication administration: 1) relative change in weight; 2) the proportion of patients losing at least 5% of postsurgical weight; 3) proportion losing at least 10% of postsurgical weight, and 4) patients losing at least 15% of postsurgical weight. Secondary efficacy endpoints included changes in BMI and resolution of obesity related co-morbidities (hypertension, type 2 diabetes, OSA, dyslipidemia, and NAFLD). We defined resolution of obesity related co-morbidities as: 1) hypertension – no longer requiring medication to maintain a normal blood pressure of < 120/80; 2) type 2 diabetes – hemoglobin A1c of < 6.5; 3) OSA- no longer requiring CPAP as assessed by overnight polysomnography, 4) dyslipidemia – normalization of lipid values without lipid lowering therapy; and 5) NAFLD – normalization of liver function tests.

Statistical analysis

Data collected from electronic medical records were converted into variables for analysis. Patient demographic characteristics, preoperative baseline characteristics, and patient weight histories at 3 distinct time periods (nadir weight after surgery before medical treatment, at initiation of medical therapy with weight loss medications, and at nadir weight post medical treatment) were summarized with descriptive statistics overall and by surgical cohort RYGB and SG. We defined the treatment period as time between date weight loss medical therapy was initiated to the date when nadir weight is achieved with therapy. We stratified patients who started weight loss medication treatment at their plateau weight versus those who started medication after weight regain occurred. Plateau weight was defined as within 3% of nadir weight achieved after bariatric surgery.

Logistic regression analyses were performed to build a model with medications used over the treatment period as our candidate predictor variables for our 3 binary outcomes of 5%, 10%, and 15% weight loss. We adjusted for the type of surgery performed and their BMI at start of medication by including them as covariates in our model. We then performed logistic regression analyses with candidate predictor variables based on our demographic and baseline characteristics. Odds ratios [ORs] and corresponding P values were estimated. All analyses were performed in Stata software (Version 14.1 of the Stata/IC System for Windows, StataCorp LP, College Station, TX).

Results

Participants

Baseline characteristics of study patients are denoted in Table 1. Of the 5110 patient records that were reviewed, 319 (6.2%) met criteria for inclusion. Patients were predominantly female (n = 247; 77%), Caucasian (n = 231; 72.4%), and had an age from 20–73 years (mean = 45). At the time of surgery, RYGB patients had higher mean BMI (49.1 kg/m^2; standard deviation [SD] = 9.0) versus (45.0 kg/m^2; SD = 7.8), higher percentage of obesity related comorbidities, took longer to reach their weight plateau after surgery, and were less likely than SG patients to have been prescribed weight loss medications before surgery. At the start of medication as denoted in Table 2, the mean weight and BMI of RYGB (BMI = 36.8 kg/m^2; SD = 6.3) and SG (BMI = 37.5 kg/m^2; SD = 7.4) were similar, but RYGB patients had a longer time elapse between surgery (59.3 months; SD = 36.7) and the start of medication compared with patients who had an SG (23.2 months; SD = 15.3). At the nadir weight postweight loss medication, the mean BMI was similar between the RYGB (BMI = 35.2 kg/m^2; SD= 6.2) and SG (BMI = 34.3 kg/m^2; SD =6.96).

Weight loss medications and response

A majority of study patients underwent RYGB (80.9%; n = 258), but patients in both groups were often trialed on several medications over the course of treatment (Supplemental Table 1). The average number of medications for study patients was 2. Patients were more likely to be prescribed medications after weight regain (78.5%; n = 249) had occurred than at their plateau (21.5%; n = 68) (Table.3).However, patients that were prescribed medications at their plateau had a higher cumulative total weight loss (32.3%) than those who were prescribed medication after weight regain (26.8%) (P = .486). More than half (56%; n = 178) of all study patients lost ≥ 5% of their postsurgical total weight with treatment. There were also several high responders to medication after surgery with 30.1% of patients (n = 96) and 16% (n = 51) losing ≥ 10% and ≥ 15% of their postsurgical total weight, respectively (Table 3).

Figure 1 shows an example of a patient who achieved 26% of total body weight loss 12 months after an RYGB. The patient achieved a nadir BMI of 33 and had weight regain of > 6.5% of her total weight lost with an increase in BMI to 36. With the use of weight loss medications (topiramate and phentermine), she has surpassed her nadir weight loss achieved with weight loss surgery and has a current BMI of 26.

The most frequently prescribed medications were topiramate, phentermine, metformin, bupropion, and zonisamide (Supplemental Table 2). In our model, which was adjusted for type of surgery (RYGB versus SG) and BMI at the start of medications, topiramate was the only medication that demonstrated a statistically significant response for weight loss with patients being twice as likely to lose at least 10% of their postsurgical weight when placed on this medication (OR = 1.9; $P = .018$) (Table 4). The mean weight loss in patients who were prescribed topiramate was 20.2 lbs (SD =.24.5), whereas patients who were not prescribed topiramate had a mean weight loss of 13.99 lbs (SD = 13.6). We did not find that the number of medications prescribed over the treatment course to be a significant factor in the percentage of total weight loss (Supplemental Tables 3 and 4)

Predictors of weight loss medication response

We evaluated predictors of response to weight loss medications and we found that patients who underwent RYGB were more likely to lose weight compared to those who underwent SG (Table 5). Regardless of the postoperative BMI, patients who underwent RYGB were significantly more likely to lose ≥ 5% of their postsurgical total weight with the aid of weight loss medications (OR =.2.86; $P = .001$). Females were also more likely to lose ≥ 5% (OR =.1.81; $P = .031$). For every unit increase in BMI based upon preoperative weight, there was a higher likelihood of postoperative response to weight loss medication. Patients who had one obesity co-morbidity at the time of surgery were significantly less likely to lose ≥ 15% of their postsurgical total weight with the use of medications after surgery (OR .=.16; $P = .014$). Patients who had OSA were significantly less likely to lose ≥ 10% of their postsurgical total weight (OR =.45; $P = .005$). Patients who had a history of psychiatric co-morbidity were more likely to lose ≥ 15% of their postsurgical total weight (OR = 1.4; $P = .002$). Of note, type 2 diabetes was not a predictor of weight loss response with medications after surgery.

Discussion

The principal finding in our study is that many patients who received weight loss medication after bariatric surgery had an additional weight loss benefit. The mean of this added weight loss was −7.6% (17.8 lbs) of total postsurgical weight. After further stratification, we found that patients who were prescribed medication at weight plateau lost a similar amount of weight compared to those who were prescribed medication after weight regain, (− 6.9% or 16.1 lbs and − 7.7% or 18.2 lbs) consistent with findings reported in previous literature [27,28,32,33]. Consequently, total weight loss percentage from preoperative status was higher in patients who were prescribed medications at their plateau than in those patients who were prescribed medication after weight regain had occurred (32.3% versus 26.8%; $P = .486$). While not confirmed with our study results, it is likely that the optimal time to initiate weight loss medication after bariatric surgery is once the patient has reached their weight plateau. Of the 317 study patients included in our analysis, more than half achieved meaningful weight loss with treatment with weight loss medication. In particular, after starting weight loss medications, 56% of study patients achieved ≥ 5% additional weight loss, 30% achieved ≥ 10%, and 16% of study patients achieved ≥ 15% additional weight loss. Losses of this magnitude are considered clinically significant because of their reduction

of cardiovascular disease risk factors, including triglycerides levels, blood pressure, and blood glucose levels [34,35].

Weight loss medications assist patients with obesity (BMI Z30 kg/m^2) and patients who are overweight (i.e., BMI Z27 kg/m^2) with obesity associated co-morbidities to achieve long term weight loss [36]. To date, there is a paucity of published literature on utilizing weight loss medication as an adjunct to bariatric surgery for individuals who have had inadequate weight loss or for individuals who have regained weight after undergoing bariatric surgery. We are aware of only a few studies that have examined this issue [27,28,32,33].

In a prospective study examining the use of phentermine and fenfluramine in combination in individuals who regained weight 18 months after RYGB or biliopancreatic diversion, Jester et al. reported that weight loss ranged from 4.5 to 22.7 kg, over a 12-week course of treatment, corresponding to 8%–65% of excess weight (EWL) [32].

Another retrospective study by Schwartz et al. examined the use of phentermine and combination phentermine/topiramate in individuals who underwent RYGB or laparoscopic gastric banding (LAGB) who desired additional weight loss one year after their surgical procedure [33]. In their study, the group reported that at 90 days weight loss was 6.35 kg (12.8% EWL) and 3.81 kg (12.9% EWL) in the phentermine and phentermine/topiramate groups respectively [33]. Furthermore, in a retrospective study, Pajecki et al. examined the use of glucagon-like peptide-1 agonist liraglutide over a period of 12.5 ± 4 weeks in 15 individuals who had >15 % of weight regain 2 years after bariatric surgery. The group reported weight losses of 2–18 kg (− 7.5 ± 4.3 kg) [27]. Finally, Zilberstein et al., in a prospective study using topiramate for 3 months after LAGB in 16 patients with binge eating disorder, reported a mean increase in EWL from 20.4% to 34.1% without the need for band readjustment [28].

In our multicenter retrospective study, we examined patients that underwent either an RYGB or SG—a group that has not been studied before. Additionally, in our cohort, patients were prescribed several weight loss medications which helped us further delve into the efficacy of the different antiobesity pharmacotherapy available. We found that the use of topiramate, the most commonly prescribed medication in our cohort, was often associated with additional weight loss of ≥ 10 % of total weight. We cannot directly compare these findings to the reported outcomes from Schwartz et al. or Zilberstein et al. since the first group only compared combination phentermine/topiramate to phentermine and did not use topiramate as a monotherapy [28,33]. Furthermore, the second group used topiramate only in patients with binge eating disorder after undergoing LAGB [28]. While a number of patients in our cohort did suffer from binge eating disorder, we did not look at that subgroup specifically. In addition, we did not include any patients that have underwent LAGB [28]. The EQUATE trial [37], a randomized controlled trial that compared the use of topiramate and phentermine monotherapy to combination phentermine/topiramate over a period of 28 weeks, found that combination therapy produced significantly greater weight loss than either component as a monotherapy. However, it is important to point out that the patients in the EQUATE trial were individuals with obesity who did not undergo bariatric surgery [37]. The physiologic

changes that occur with bariatric surgery may have an influence on how patients respond to different weight loss pharmacologic agents [12].

When we evaluated predictors for weight loss, we found that patients who have undergone RYGB were more likely to achieve greater weight loss compared with patients who have undergone an SG. These findings are similar to previously published data [38]. Other positive predictors for greater response to weight loss medications after bariatric surgery were a higher BMI before surgery and the history of a psychiatric co-morbidity. It is well known that a number of antidepressants and antipsychotics are associated with significant weight gain [39–42]. Studies have reported associated improvements in mood after weight loss [43–46]. Therefore, we hypothesize that the need for these potential weight promoting medications was decreased in our cohort.

Due to the retrospective nature of our study, there are several limitations that include missing patient data, the lack of a control group for comparison, and the inability to account for the length of time that patients were placed on weight loss medications as longer medication duration may have accounted for greater weight loss. Additionally, interpretation of weight loss in our cohort should be approached cautiously due to the presence of confounding factors including concurrent treatment with weight promoting medications, co-morbidities that might predispose to weight gain such as OSA, and there are multiple indications for which many of the medications we evaluated for their weight loss potential may have been prescribed that may have led to potential inferiority of one medication versus another in our analysis. Furthermore, in our analysis we were not able to take into account the effect of diet and exercise on weight, since our patients were not following a predefined structured program. Finally, there were significant differences in the frequency of prescriptions of weight loss medications where some medications were prescribed more than others.

Despite our limitations, our study had several strengths which include a large sample size from 2 academic study sites. Other strengths include our inclusion of patients who had undergone the 2 most common procedures in the United States, RYGB and SG, and our long duration of follow-up. This long follow-up has helped us further asses the long-term efficacy of weight loss medication after bariatric surgery. Finally, the patients in our cohort received several antiobesity medications, which were beneficial in helping us to determine the potential efficacy of weight loss medications and the individual variability in response to the different agents.

Conclusions

Our study demonstrates that weight loss medications are a useful tool for patients with inadequate weight loss or weight regain after bariatric surgery. While patients who underwent RYGB were more likely to have more weight loss with the use of weight loss medications, both groups demonstrate benefit from their use. Our data also suggest that prescribing weight loss medication before weight regain occurs (at weight plateau) may result in greater amount of total weight loss from the preoperative period. Further prospective studies should be performed to detect the optimal time at which to start medications after bariatric surgery.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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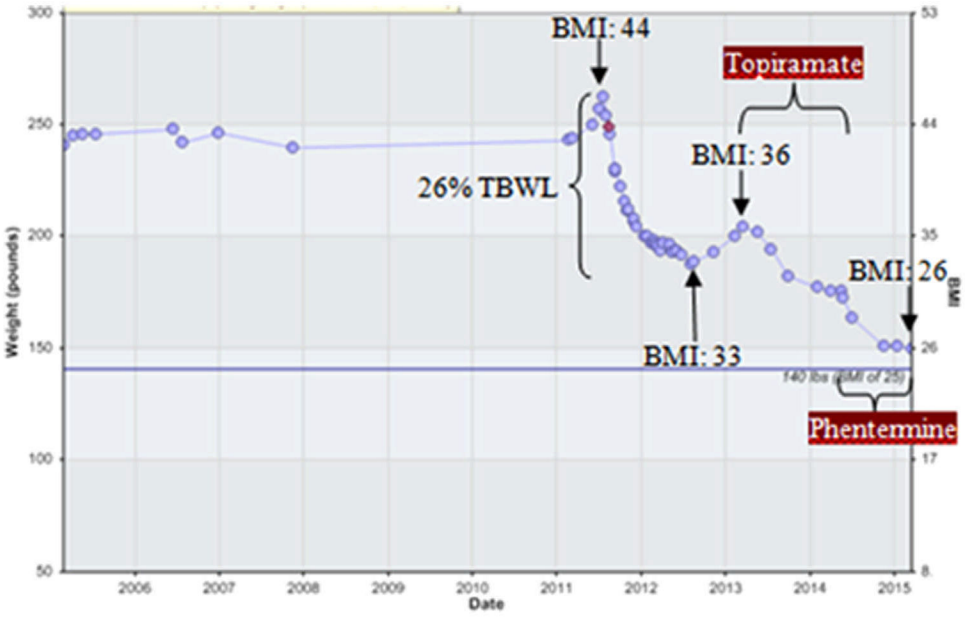

Fig. 1.

Demonstration of the utility of weight loss mediation after bariatric surgery in an RYGB patient. RYGB = Roux-en-Y gastric bypass; BMI = body mass index; TBWL = total body weight loss.

Table 1

Demographic data and baseline characteristics

Variable	All patients n = 319	Surgery type	
		Sleeve gastrectomy n = 61 (19.1%)	Roux-en-Y gastric bypass n = 258 (80.9%)
Gender			
Female	247 (77%)	46 (75%)	201 (78%)
Male	72 (23%)	15 (25%)	57 (22%)
Age at surgery (yr)			
Mean	45	47	45
Median	47	49	46
Range	20–73	20–72	20–73
Race/ethnicity			
White	231 (72.4%)	42 (68.9%)	189 (73.2%)
Hispanic	34 (10.7%)	4 (6.6%)	30 (11.6%)
black	30% (9.4%)	10 (16.4%)	20 (7.8%)
Asian	1 (.3%)	1 (1.6%)	0
Other/declined to state	23 (7.2%)	4 (6.6%)	19 (7.4%)
Preoperative characteristics			
Mean weight (lbs)	296 (SD = 66)	274 (SD = 57)	301 (SD = 67)
Mean BMI (lbs/in^2)	48.3 (SD = 8.9)	45 (SD = 7.8)	49.1 (SD = 9.02)
Obesity Class			
Class I (BMI 30–34.9)	4 (1%)	0	4 (2%)
Class II (BMI 35–39.9)	53 (17%)	19 (31%)	34 (13%)
Class III (BMI ≥40)	262 (82%)	42 (69%)	220 (85%)
Co-morbid conditions (Individual)			
Hypertension	177 (43.3%)	31 (50.8%)	146 (56.6%)
Type II diabetes	116 (36.4%)	20 (32.8%)	96 (37.2%)
OSA	106 (33.2%)	20 (32.8%)	86 (33.3%)
Dyslipidemia	184 (56.7%)	34 (55.7%)	150 (58.1%)
NAFLD	235 (73.7%)	33 (54.1%)	202 (78.3%)
Mental illness	164 (51.4%)	23 (37%)	141 (54.7%)

BMI = body mass index; NAFLD = nonalcoholic fatty liver disease; OSA = obstructive sleep apnea; SD = standard deviation.

Table 2

Postoperative patient characteristics and weight history after surgery, before medications, and after treatment

Co-morbid conditions (individual)	All patients n = 319	Surgery type	
		Sleeve gastrectomy n = 61 (19.1%)	Roux-en-Y gastric bypass n = 258 (80.9%)
Hypertension	68 (21.3%)	11 (18.0%)	54 (20.9%)
Preoperative patients (n = 177) who achieved resolution (%)	112 (63.3%)	20 (64.5%)	92 (63%)
Type II diabetes	54 (16.9%)	12 (19.7%)	42 (16.3%)
Preoperative patients (n = 116) who achieved resolution (%)	62 (53.4%)	8 (40.0%)	54 (56.3%)
OSA * (n = 318)	47 (14.8%)	4 (6.6%)	43 (16.7%)
Preoperative patients (n = 106) who achieved resolution (%) *	59 (55.7%)	16 (80.0%)	43 (50.6%)
Dyslipidemia	104 (32.6%)	17(27.9 %)	87 (33.7%)
Preoperative patients (n = 184) who achieved resolution (%)	88 (47.8%)	18 (52.9%)	70 (46.7%)
NAFLD	187 (58.6%)	24 (39.3%)	163 (63.2%)
Preoperative patients (n = 235) who achieved resolution (%)	51 (21.7%)	9 (27.3%)	42 (20.8%)
Mental illness † (n = 314)	152 (48.4%)	18 (29.5%)	134 (51.9%)
Preoperative patients (n = 164) who achieved resolution (%) †	9 (5.5%)	3 (13.0%)	6 (4.3%)

		Surgery type	
Postoperative nadir weight before medication	All patients n = 319	Sleeve gastrectomy n = 61 (19.1%)	Roux-en-Y gastric bypass n = 258 (80.9%)
Mean BMI (Ibs/in^2) §	33.3 (SD = 6.5)	35.1 (SD = 6.2)	32.9 (SD = 6.5)
Mean time to achieve nadir (mo) ¶	15.7 (SD = 10.8)	10.8 (SD = 6.6)	16.8 (SD = 11.3)
Average weight loss at nadir weight (lbs) §	91.9 (SD = 39.7)	60 (SD = 26.5)	100 (SD = 38.5)
At start of medication			
Mean weight (lbs) //	229.4 (SD = 53.3)	225.3 (SD = 49.2)	230.3 (SD = 54.3)
Mean BMI (lbs/in^2)	37.4 (SD = 7.2)	36.8 (SD = 6.3)	37.5 (SD = 7.4)
Time elapsed between surgery and start of medication (months)			
Mean (SD)	52.4 (SD = 36.7)	23.2 (SD = 15.3)	59.3 (SD = 36.7)
Min	2.1	2.3	2.1
Max	167	88.7	167
Postmedication treatment - at nadir weight			
Mean weight (lbs)	211. 6 (SD = 50.4)	215. 5 (SD = 48.9)	210.7 (SD = 50.8)
Mean BMI (lbs/in^2)	34.5 (SD = 6.8)	35.2 (SD = 6.2)	34.3 (SD = 6.96)

BMI = body mass index; NAFLD = nonalcoholic fatty liver disease; OSA = obstructive sleep apnea; SD standard deviation.

* Missing data for 1 patient.

† Missing data for 5 patients.

§ n = 318, missing data.

¶ n = 306, missing data.

$^{//}_{n = 317}$.

Table 3

Mean weight change after treatment by subgroup

Subgroup	Weight change (lbs)	(%)*	*P* value	95% CI
All patients (n = 317)†	−17.8 (SD = 21.1)	−7.6 (SD = 7.8)		
Patients prescribed medication at weight plateau (n = 68, 21.5%)‡	−15.8 (SD = 27.8)	−6.9 (SD = 8.8)	.3901§	(−20.1, −15.4)
Patients prescribed medication at weight regain (n = 249, 78.5%)‡	−18.3 (SD = 19.0)	−7.7 (SD = 7.6)		
Surgery type				
Sleeve gastrectomy (n = 61)	−9.8 (SD = 13.5)	−4.3 (SD = 5.7)	.001§	(−20.1, −15.4)
Roux-en-Y gastric bypass (n = 256)	−19.7 (SD = 22.2)	−8.3 (SD = 8.1)		
Patients who lost ≥5% total weight with treatment (n = 172, 54%)	−29.7 (SD = 21.9)	−12.6 (SD = 7.2)		
Patients who lost ≥ 10% total weight with treatment (n = 96, 30.3%)	−40.7 (SD = 23.7)	−17.1 (SD = 6.7)		
Patients who lost ≥ 15% total weight with treatment (n = 49, 15.4%)	−52.9 (SD = 27.7)	−22.02(SD = 6.2)		

CI = confidence interval; SD = standard deviation.

*Calculated this number as [(weight at nadir postmedications) – (weight at start of medication)]/ (weight at start of medication).

†Missing data for 2 patients.

‡Plateau defined as weight that is within 3% above or below nadir weight postoperatively before medication. If above 3% patient defined as starting medication at weight regain.

§Two-sample t-test of means conducted for posttreatment weight change (lbs).

Table 4

Logistic regression analysis with most commonly used medication as predictor

Medication	Number of patients (%)	Treatment period weight loss								
		≥5%			≥10%			≥15%		
		OR	*P* value	95% CI	OR	*P* value	95% CI	OR	*P* value	95% CI
Topiramate	194 (60.8%)	1.03	.901	(.65, 1.64)	1.9	.018	(1.1, 3.2)	2.08	.041	(1.03, 4.2)
Phentermine	121 (37.9%)	1.18	.504	(.73, 1.89)	1.09	.729	(.66, 1.82)	1.42	.27	(.63, 1.77)
Metformin	123 (38.6)	1.01	.98	(.63, 1.61)	1.15	.583	(.70, 1.90)	.96	.91	(.51, 1.8)
Bupropion	75 (23.5%)	.92	.776	(.54, 1.58)	1.1	.753	(.62, 1.93)	1.23	.55	(.62, 2.46)
Zonisamide	65 (20.4%)	1.15	.643	(.64, 2.04)	1.03	.914	(.57, 1.89)	.97	.94	(.46, 2.07)

CI = confidence interval; OR = odds ratio.

Model is adjusted for type of surgery and BMI at start of medications.

Table 5

Logistic regression by predictor variable

Predictor	Treatment period weight loss											
	≥5%				≥10%				≥15%			
	OR	*P* value	95% CI	R^2	OR	*P* value	95% CI	R^2	OR	*P* value	95% CI	R^2
Surgery type												
Gastrectomy (reference)												
RYGB	2.96	.0001	(.44, 1.97)	.0323	3.47	.002	(1.58, 7.62)	.0307	4.23	.019	(1.27, 14.1)	.0291
RYGB *	2.97	.0001	(1.64, 5.37)	.0404	3.4	.002	(1.55, 7.54)	.0307	4.18	.02	(1.25, 13.9)	.0323
RYGB †	2.92	.001	(1.54, 5.51)	.0324	3.5	.003	(1.53, 8.0)	.0307	4.6	.016	(1.33, 15.9)	.0301
Gender‡												
Male (reference)												
Female	1.79	.031	(1.05, 3.05)	.0108	1.7	.093	(.92, 3.14)	.0077	1.37	.431	(.63, 2.97)	.0024
Female *	1.75	.04	(1.03, 2.98)	.0427	1.8	.034	(1.05, 3.1)	.0427	1.35	.457	(.61, 2.9)	.0312
Age												
20–30 (reference)												
31–50	1.28	.28	(.82, 1.99)	.0027	.97	.894	(.6, 1.56)	.0000	1.08	.817	(.55, 2.12)	.0023
51 +	.82	.406	(.52, 1.3)	.0016	.94	.793	(.57, 1.54)	.0002	.92	.817	(.47, 1.81)	.0023
Weight when medications prescribed												
At plateau (reference)												
At regain	1.44	.18	(.84, 2.5)	.0041	1.15	.635	(.64, 2.09	.0006	1.08	.847	(.51, 2.29)	.0001
At regain *,§	.98	.948	(.54, 1.78)	.0527	.76	.412	(.39, 1.46)	.0463	.71	.409	(.32, 1.6)	.0372
Race/ethnicity												
Caucasian (reference)												
All other	1.59	.069	(.96, 2.64)	.0077	.95	.859	(.56, 1.63)	.0001	1.18	.628	(.61, 2.29)	.0008
BMI class - at baseline preoperatively												
For 1 unit increase	1.02	.1	(1.0, 1.05)	.0063	1.03	.052	(1.0, 1.05)	.0096	1.03	.097	(1.0, 1.06)	.0097
Class I (reference)												
Class II	.54	.043	(.30, .98)	.0095	.55	.102	(.27, 1.12)	.0075	.52	.19	(.19, 1.38)	.0072
Class III	1.53	.15	(.86, 2.72)	.0048	1.79	.097	(.9, 3.56)	.0076	1.68	.26	(.68, 4.17)	.0051

Predictor	Treatment period weight loss											
	≥5%				≥10%				≥15%			
	OR	*P* value	95% CI	R^2	OR	*P* value	95% CI	R^2	OR	*P* value	95% CI	R^2
Co-morbities - number present at preop[§]												
0 (reference)												
1	1.03	.929	(.55, 1.91)	.0428	.9	.761	(.46, 1.77)	.0383	.29	.045	(.08, .97)	.0510
2	1.14	.66	(.65, 2.0)	.0432	1.19	.566	(.66, 2.14)	.0388	1.38	.38	(.67, 2.81)	.0339
3	.70	.19	(.41, 1.19)	.0467	.62	.116	(.34, 1.13)	.0447	.87	.721	(.42, 1.82)	.0317
4	.88	.65	(.51, 1.52)	.0432	.79	.453	(.44, 1.45)	.0395	.9	.785	(.43, 1.91)	.0315
5	2.01	.208	(.68, 5.99)	.0466	2.06	.159	(.75, 5.6)	.043	1.61	.431	(.49, 5.23)	.0333
Type of co-morbidity[§]												
HTN	.86	.526	(.54, 1.37)	.0437	.79	.347	(.48, 1.3)	.0403	.8	.494	(.42, 1.5)	.0329
Diabetes	1.36	.212	(.84, 2.2)	.0463	.9	.692	(.54, 1.51)	.0384	1.02	.944	(.54, 1.95)	.0312
OSA	.77	.302	(.47, 1.26)	.0452	.47	.01	(.27, .84)	.0559	.81	.541	(.40, 1.6)	.0326
Dyslipidemia	.83	.434	(.52, 1.32)	.0441	1.16	.56	(.7, 1.9)	.0389	1.22	.543	(.64, 2.3)	.0326
NAFLD	.98	.946	(.58, 1.67)	.0428	1.21	.53	(.67, 2.17)	.039	1.25	.573	(.58, 2.7)	.0324
Mental illness	1.04	.878	(.65, 1.64)	.0428	1.41	.177	(.86, 2.32)	.0427	1.3	.019	(1.05, 1.62)	.0526
Time to achieve nadir weight postop before meds[§,¶]												
≤12 mo (reference)												
13–36 mo	.97	.91	(.61, 1.56)	.0428	1.31	.29	(.80, 2.15)	.0409	1.93	.041	(1.03, 3.61)	.0467
>36 mo	.84	.756	(.29, 2.45)	.0430	.73	.601	(.22, 2.39)	.0387	.33	.292	(.04, 2.59)	.0467
BMI at start of medications (every 1 unit increase)	1.03	.052	(1.0, 1.07)	.0089	1.02	.111	(.99, 1.06)	.0065	1.02	.291	(.98, 1.06)	.0040

BMI = body mass index; CI = confidence interval; HTN = hypertension; NAFLD = nonalcoholic fatty liver disease; OR = odds ratio; obstructive OSA = obstructive sleep apnea; RYGB = Roux-en-Y gastric bypass.

[*] Adjusted for BMI at start of medications.

[†] Adjusted time elapse between surgery date and start of medications.

[‡] Adjusted for type of surgery by including as covariate.

[§] Adjusted for type of surgery and gender.

[¶] n = 306, missing this data for 13 patients.