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Weight loss maintenance after bariatric surgery

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Abstract

Metabolic and bariatric surgery (MBS) is an effective treatment for patients with morbid obesity and its comorbidities. However, many patients experience weight regain (WR) after achieving their nadir weight. Establishing the definition of WR is challenging as postoperative WR has various definitions. Risk factors for WR after MBS include anatomical, racial, hormonal, metabolic, behavioral, and psychological factors, and evaluating such factors preoperatively is necessary. Long-term regular follow-up and timely treatment by a multidisciplinary team are important because WR after surgery is multi-factorial. Although lifestyle interventions that focus on appropriate dietary education, physical activity education or interventions, and behavioral psychological interventions are suggested, more well-designed studies are needed because studies evaluating intervention methods and the effectiveness of WR prevention are lacking. Anti-obesity drugs can be used to prevent and manage patients with WR after MBS; however, more research is needed to determine the timing, duration, and type of anti-obesity drugs used to prevent WR.

Key Words: Metabolic and bariatric surgery; Weight regain; Obesity; Roux-en-Y gastric bypass; Laparoscopic sleeve gastrectomy

Core Tip: Metabolic and bariatric surgery (MBS) is an evidence-based treatment for morbid obesity that contributes to sustainable weight loss over long-term periods. Unfortunately, post-MBS weight regain (WR) still occurs at a considerable rate, and its incidence continues to increase annually. This review summarizes updated information on weight trajectories after MBS, definitions of postoperative WR, factors contributing to postsurgical WR, and strategies to prevent WR after sleeve gastrectomy or Roux-en-Y gastric bypass.

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INTRODUCTION

Obesity is a chronic disease that results from a positive imbalance between energy intake and expenditure. As it is a pandemic-associated disease with comorbidities such as hypertension, diabetes, dyslipidemia, and cardiovascular disease, its effective treatment is urgently required. Metabolic and bariatric surgery (MBS) is considered the best treatment option for morbid obesity and its comorbidities [1-5]. Generally, MBS is recommended for individuals with obesity with a body mass index (BMI) of ≥ 30 kg/m^2 and the presence of a metabolic disease or BMI of ≥ 35 kg/m^2, regardless of the presence, absence, or severity of comorbidities. In addition, the BMI threshold for MBS in the Asian population is lower because the prevalence of metabolic diseases in Asians is higher at lower BMIs than that in non-Asians[6,7]. Currently, laparoscopic sleeve gastrectomy (LSG) and Roux-en-Y gastric bypass (RYGB) are the standard surgical procedures for weight loss (WL) worldwide[8,9]. WL outcome of MBS is superior to that of other obesity treatments, including lifestyle interventions and anti-obesity drugs[10,11], and its durability has been proven in many studies[11-13]. Nonetheless, many patients experience weight regain (WR) after reaching their nadir weight[14,15]. This review aims to provide updated information on weight trajectories after MBS, the definitions of postoperative WR, factors contributing to WR postoperatively after surgery, and strategies to prevent WR after LSG or RYGB.

WEIGHT TRAJECTORIES AFTER BARIATRIC SURGERY

MBS outcomes are reasonably durable. However, WR is a critical issue requiring attention after both RYGB and LSG procedures. In a cohort study that evaluated the 10-year weight change among 1787 patients treated by RYGB, patients who had undergone RYGB lost 31.0% (95% confidence interval: 30.4%-31.6%) of their baseline weight at 1 year. They lost 21% more of their baseline weight at 10 years compared with their nonsurgical matches[12]. In addition, 405 patients (71.8%) who had undergone RYGB maintained ≥ 20% WL, and 40% maintained > 30% WL at 10 years. These results are similar to those of the Swedish Obese Subjects study[16]. Although less WL was observed in LSG than in RYGB, LSG is also an effective and durable surgery, sustaining > 50% of overweight (% excess WL) after 5 years[17]. A study involving individuals with obesity who underwent LSG at three Austrian obesity centers revealed that these individuals reached their lowest weight (37.0%) in 1 year and maintained a WL of 31.5% after 15 years[18]. However, WR is a critical issue requiring attention in both surgical procedures. de Hollanda *et al*[19] analyzed various WL patterns from 658 participants who had undergone RYGB and LSG. They categorized the study participants as good WL responders (excess WL ≥ 50% at nadir weight and throughout follow-up), primarily poor WL responders (excess WL < 50% at nadir weight and thereafter), and secondarily poor WL responders (excess WL ≥ 50% at nadir weight, but < 50% at the last follow-up visit). After 55.7 mo of follow-up, 75.7 % were good WL responders, 4.7% were primarily poor WL responders, and 19.6% were secondarily poor WL responders. A recent prospective cohort study among 1406 participants who underwent RYGB reported that their maximal WL was 37.4% of the preoperative weight, which was achieved after a median of 2 postoperative years [20]. The rate of WR was the highest during the first year after reaching nadir weight, although it continued to increase throughout the follow-up period.

DEFINITIONS OF POST-BARIATRIC SURGERY WR

Various definitions of WR after MBS are used in currently published data[20-32] (Table 1). Among them, the definition "Regain to a BMI > 35 kg/m^2 from nadir" was the most preferred in a survey conducted

Table 1 Definitions of weight regain after metabolic and bariatric surgery

Measurements, unit	Suggested definitions
EWL, %	> 25% EWL% regain from nadir[21,22]
Body weight, kg	≥ 10 kg weight regain from nadir[20,23,24]
	Any weight regains[25]
	Any weight regains after type 2 diabetes remission[26]
Body weight, %	≥ 10%[20], ≥ 15% TBW regain from nadir[20,27]
	≥ 10%[20,28], ≥ 20%[20,29], ≥ 25%[20,30] TBW regain from maximum weight loss
Body mass index	≥ 5 kg/m^2 body mass index regain from nadir[31]
	Regain to a body mass index > 35 kg/m^2 from nadir[32]

%EWL = [(pre-surgery weight - follow-up weight)/(pre-surgery weight - ideal weight)] × 100; maximum weight loss = preoperative weight - nadir weight; TBW: Total body weight.

through the International Bariatric Club Social Media Forum[33]. However, a consensus on the definition of WR is still lacking, aside from the only consensus that the definition of WR is desperately needed.

Previous systematic reviews have reported that self-reported or direct measurement-based mean or median WR from a mean of 3 to 10 years post-LSG or post-RYGB ranged from 7.3% to 87%, with different definitions of WR[14,15,34]. In a 5-year retrospective follow-up of 96 patients who had undergone LSG, WR rates under the same conditions ranged widely from 9% to 91% because of different WR definitions[35]. Moreover, Voorwinde *et al*[23] reported WR rates of 16%-87% over a 5-year period in 868 patients who had undergone LSG or RYGB, with different definitions of WR. Therefore, WR occurrence rates have a wide range owing to various WR diagnostic definitions. In addition, Istfan *et al*[36] proposed a new “significant” and “rapid” WR definition considering the rate of weight increase relative to nadir weight per 30-d intervals, emphasizing the importance of early WR detection and timely intervention by multidisciplinary teams. Further research is required to establish a consensus definition of WR.

RISK FACTORS FOR WR

Anatomical factors

One possible cause of post-LSG WR is the gradual expansion of gastric volume, which attenuates the restrictive effect and eventually reduces satiety and increases food intake[37]. This is due to the physiological distension of the remaining stomach over time and incomplete gastric fundus removal[38,39], which depends on the skill of the surgeon. Post-RYGB WR is associated with satiety loss due to anatomical abnormalities such as gastric pouch dilatation or gastrojejunal (GJ) anastomosis stoma outlet [40]. In 205 post-RYGB WR patients who underwent upper endoscopy, 58.9% had a large GJ stoma, 28.8% had a large gastric pouch, and the rest had both[41]. Another cause is gastro-gastric fistula, which allows food to enter the bypassed stomach and reduces the effect of restriction and malabsorption during bypass surgery[42]. However, such a condition is rare, with an incidence of 0% to 1.7%[43].

Racial factors

Several studies have demonstrated that African Americans (AAs) are more susceptible to WR than Caucasians[44,45]. A meta-analysis reported that AAs lose significantly less weight than Caucasians, with an 8.4% mean deficit in the percentage of excess WL[46]. Although the reason for this racial disparity remains unclear, biological, psychological, genetic, and socioeconomic factors may all play a role. Resting energy expenditure and aerobic capacity have been reported to be significantly lower in Black participants after WL[47,48]. Moreover, previous studies have demonstrated racial differences in the postprandial responses of appetite-regulating hormones, such as ghrelin and glucagon-like peptide 1 (GLP-1)[49,50]. AAs have less physical activity and a higher caloric diet than Caucasians, although several studies have not identified a significant difference in calorie intake and nutrition composition between the two groups[51,52]. A lower socioenvironmental background may also contribute to the racial differences in WL after bariatric surgery[53,54].

Hormonal and metabolic factors

Representative gut hormones include hunger hormones such as ghrelin and satiety hormones such as pancreatic peptide YY (PYY), GLP-1, and gastric inhibitory polypeptide. MBS has both mechanical intake restriction and absorption inhibitory effects. After LSG, ghrelin levels decrease and GLP-1 and PYY levels increase. These hormonal changes accelerate WL[55]. However, plasma ghrelin levels in patients who experienced WR are higher 5 years after LSG than at 1-year follow-up[56]. In contrast, nutrient-stimulated secretion of PYY and GLP-1 is enhanced after MBS, which is more pronounced after RYGB than after LSG[57]. However, the levels of both hormones are lower in WR patients[58].

Post-bariatric hypoglycemia is a risk factor for WR. In a previous study, one-third of patients who underwent RYGB or LSG experienced hypoglycemia-related symptoms[59]. A prospective study evaluated body weight changes over 2 years after LSG and investigated the role of serotonin in regulating energy balance[60]. In this study, serotonin significantly increased one-year postoperatively, with further significant increase within 24 mo postoperatively in the weight-regained group compared to that in the maintained-lost-weight group. Based on the data, the increased serotonin concentration might contribute to the increase in hunger and food intake after LSG.

Additionally, MBS results in significant changes in resting energy expenditure and metabolic adaptation, which may be partially related to WR. Previous studies have indicated that the measured resting energy expenditure decreased by 20%-30% at 12 mo after MBS[61-63]. However, other studies have reported no substantial change in resting energy expenditure postoperatively[64,65]. Thus, further research is necessary on this front.

Diet and physical activity factors

Owing to anatomical and hormonal changes, calorie intake, a major factor in WL, decreases immediately after MBS. However, reduced appetite hormone levels and recurrence of problematic eating habits often cause progressive weight gain in patients. Adherence to a postoperative diet is associated with greater postoperative WL[66], whereas poor diet quality, characterized by excessive intake of calories, snacks, sweets, and fatty foods, is associated with WR[67]. A cross-sectional study reported that poor WL outcomes in patients 10 to 15 years after RYGB were associated with an intake of high energy and energy-dense foods and low physical activity[68]. A perspective study reported that patients with obesity who had WR 12 years after RYGB consumed higher amounts of carbohydrates and alcohol than those who maintained WL[69]. Grazing and binge eating disorders are considered risk factors for post-MBS WR[70,71]. Exercise is also correlated with greater postoperative WL; however, standard exercise guidelines for WL and maintenance in patients who underwent MBS have yet to be established[72]. As expected, a sedentary lifestyle and low physical activity contribute to post-MBS WR [67,70].

Psychological factors

In a meta-analysis encompassing 33 articles, including a total of 101223 patients who underwent MBS, depression was associated with WR[73]. A history of preoperative depression or antidepressant medication use can exacerbate postoperative depression, which is more prevalent among patients who regained postoperatively. Postoperative self-esteem and lack of social support also contribute to post-MBS WR[74]. In addition, eating disorders, such as emotional eating, night eating syndrome, loss of control, picking and nibbling, binge eating, and binge eating disorder, affect weight control after MBS [75]. Even if patients have problematic eating behaviors preoperatively, in most cases, these eating habits improve postoperatively. However, patients with higher emotional eating scores often experience depression and have a higher risk of insufficient WL after RYGB[76]. The occurrence of depression and anxiety symptoms is associated with WR in the long term[77]. A depressed mood is associated with emotional eating and low physical activity, worsens weight control, and is associated with WR[67,78]. A recent longitudinal study evaluating the relationship between different psychological factors and post-MBS WL has demonstrated that non-planning impulsivity is the principal factor that improves adherence to diet plans[79]. This study suggested that adherence to the nutritional plan and non-planning impulsivity are short-term predictors of WL. Therefore, comorbid psychopathological problems in patients before and after MBS surgery should be identified and closely monitored to provide appropriate psychiatric management[75].

STRATEGIES TO PREVENT WR

Diet and physical activity intervention

Clinical practice guidelines for patients undergoing MBS emphasize the importance of a team-based approach to patient care, including perioperative dietary and physical activity counseling, lifelong lifestyle support, and medical management[36,80]. Nutritional guidelines recommend regular food intake with adequate calories, no concentrated sweets, and sufficient protein and fiber intake[81]. A randomized controlled trial (RCT) has demonstrated that comprehensive nutrition education and behavior modification intervention can improve WL and physical activity at 12 mo postoperatively in Hispanic Americans who had undergone RYGB[82]. However, a recent RCT did not identify positive effect of lifestyle intervention compared to the usual care group on WR prevention in 165 patients after

RYGB[83]. The intervention group offered 16 group meetings over 2 years with a focus on healthy diet, physical activity, and behavioral strategies to prevent WR. Differences in these results may be due to differences in the composition and content of the intervention. A well-structured program with individualized interventions and group interventions for effective WR prevention as well as more intervention studies is needed. Whey protein supplementation for 16 wk has been proven to be effective for WL and fat mass loss in 34 women who regained weight ≥ 24 mo after bariatric surgery[84].

Because eating disorders and related psychological problems affect the patient's dietary habits, the presence of such problems should be assessed and appropriate interventions should be initiated. Timely counseling and dietary interventions should be emphasized to address the specific dietary challenges of patients with postoperative WR.

Post-MBS physical activity guidelines have yet to be established. Since most studies evaluating the weight maintenance effect of physical activity programs after MBS are limited to early postoperative stages, interventional clinical trials with more long-term structured exercise programs are needed for post-MBS WR[85]. Nonetheless, physical activity after MBS can be expected to increase daily energy consumption, maintain muscle mass and function, and improve cardiovascular function[86]. Therefore, 150-300 min of moderate-intensity physical activity, 75-150 min of vigorous-intensity physical activity, or an equivalent combination of weekly moderate-intensity and vigorous-intensity aerobic physical activity and regular muscle-strengthening activity is recommended for health promotion according to the World Health Organization 2020 guidelines[87]. Oppert *et al*[88] conducted a 5-year follow-up study after publishing an RCT demonstrating that resistance exercise and protein supplementation after RYGB improved muscle strength in the first 6 postoperative months without significantly affecting WL and body composition[89]. Contrary to the results of a recent meta-analysis that exercise training after bariatric surgery improved physical fitness and led to a small additional weight and fat loss postoperatively[90], the initial favorable effect of exercise training and protein supplementation in increasing muscle strength postoperatively was not sustained after a 5-year follow-up in this study. Instead, these results suggested that increasing physical activity of at least moderate intensity can promote weight maintenance postoperatively.

Anti-obesity drugs

Anti-obesity drugs are useful adjuncts to diet and exercise for patients with obesity. They are also recommended for obese patients who experience post-MBS WR or have a poor postoperative response. A recent prospective study reported that patients who received a phentermine/topiramate extended-release (phen/top) combination lost more than twice as much weight preoperatively than the control group. This combination also produced a higher rate of excess WL (-18.2%; 95% confidence interval: -32.1 to -4.4) at 2 years postoperatively when consumed from 3 mo preoperatively up to 24 mo postoperatively in 15 patients with severe obesity (BMI ≥ 50 kg/m^2) who underwent LSG[91]. In a larger prospective observational study, Suliman *et al*[92] reported a WL of approximately 6% after using prescribing 3 mg of liraglutide, a GLP-1 agonist, for over 16 wk in obese patients who have undergone MBS 4 years earlier; this finding is similar to that seen observed in obese nonsurgical patients. Retrospectively, short-term (12.5 ± 4 wk) use of liraglutide at doses from of 1.2-3.0 mg/d resulted in a mean WL of 7.5 kg in 15 patients with post-MBS WR patients (including 9 RYGB patients who underwent RYGB); all of them lost < 50% of their excess weight or gained > 15% of their nadir weight at the 2-year postoperative follow-up[93]. This is consistent with another retrospective study indicating that the administration of 1.2-3.0 mg/d of liraglutide in patients who underwent bariatric surgery patients resulted in additional WL[94]. These findings suggest that anti-obesity drugs have an additional WL effect in post-bariatric surgery patients. As such, the use of anti-obesity drugs can be considered a part of the range of a treatment options for obese patients with the challenge of poor response to MBS or post-MBS WR[95]. However, further research is needed to determine the timing, duration, and type of anti-obesity drugs for obese patients with obesity who experience post-MBS WR.

CONCLUSION

With RYGB and LSG as the representatives, MBS is by far the most effective long-term treatment for obesity, especially morbid obesity. However, post-MBS WR is an important problem with a considerable incidence. Thus, unifying various WR definitions currently used is necessary to accurately evaluate WR incidence and verify the effectiveness of obesity interventions. The risk factors for WR after MBS include anatomical, racial, hormonal, metabolic, behavioral, and psychological factors, and such factors need to be evaluated preoperatively. Although lifestyle interventions that focus on appropriate dietary education, physical activity education or interventions, and behavioral psychological interventions are suggested, RCTs focusing on preventing WR after MBS are still lacking. Therefore, more well-designed RCTs are needed to confirm the effectiveness of various interventions. Although anti-obesity drugs may be helpful in preventing WR, more research is needed to determine the timing, duration, and type of anti-obesity drugs used to prevent WR.

FOOTNOTES

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