Comparative Efficacy of Mini Gastric Bypass and Sleeve Gastrectomy in Improving Metabolic Parameters and Promoting Weight Loss in Patients with Morbid Obesity: A Cohort Study

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Abstract:

Background and Objective: Morbid obesity is associated with a wide spectrum of metabolic complications, and bariatric surgery represents the most effective intervention for achieving sustainable weight loss and alleviating these comorbidities. This study aimed to compare the efficacy of two surgical procedures, mini gastric bypass (MGB) and sleeve gastrectomy (SG), on anthropometric measurements, metabolic profiles, and clinical outcomes in patients with morbid obesity.

Methods: This prospective longitudinal cohort study included 160 patients with morbid obesity (n=80 per group) who underwent either SG or MGB in 2024 at medical centers affiliated with Kermanshah University of Medical Sciences. Body weight was assessed at baseline and at 1, 3, and 9 months postoperatively. Laboratory parameters-including fasting blood glucose, triglycerides, total cholesterol, HDL, and LDL-along with systolic blood pressure (SBP), hepatic steatosis grade, and musculoskeletal pain were evaluated at baseline and at month 9. Statistical analyses were conducted using repeated measures analysis of variance (RM-ANOVA), Bonferroni post-hoc tests, independent t-tests, and Chi-square tests in SPSS version 26, with significance set at P<0.05.

Results: The mean age of the MGB group was significantly higher than that of the SG group (*P*=0.001). Both procedures led to a significant reduction in weight over time (*P*<0.001), with a significant interaction effect between time and surgical approach (*P*=0.004). Although the absolute weight loss at the end of the month 9 did not differ significantly between the two groups (*P*=0.068), total weight loss percentage (%TWL) was significantly greater in the SG group than in the MGB group (*P*=0.002). In metabolic evaluations, MGB demonstrated significant superiority in reducing triglycerides (*P*=0.006) and total cholesterol (*P*=0.002), as well as in increasing HDL levels (*P*=0.001). However, no significant differences were observed between the two methods regarding LDL reduction (*P*=0.282), percentage reduction in fasting blood glucose (*P*=0.205), or systolic blood pressure control (*P* =0.217). Furthermore, in both groups, grade 3 hepatic steatosis was completely eradicated, and complete resolution (100%) of musculoskeletal pain was achieved by month 9 (*P*<0.001).

Conclusion: Both SG and MGB are effective surgical approaches for weight control and the management of clinical comorbidities in morbid obesity. However, SG showed superiority in percentage of TWL, whereas MGB was more effective in correcting dyslipidemia. Therefore, the choice of surgical technique should be tailored to the individual patient's metabolic phenotype.

Keywords: Gastric Bypass; Obesity, Morbid; Weight Loss

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Introduction

Obesity, a complex chronic disease with multifactorial etiology, has emerged as a critical global public health challenge. According to the World Health Organization (WHO), obesity is defined as a body mass index (BMI) of 30 kg/m^2 or higher.[1] The prevalence of this condition has increased markedly over recent decades, with projections indicating that approximately 20% of the world's population will be obese by 2030.[2]

Obesity is not only an independent risk factor for all-cause mortality but is also closely associated with a wide range of complications and comorbidities. Among the most prominent are type 2 diabetes mellitus (T2DM), hypertension, dyslipidemia, non-alcoholic fatty liver disease (NAFLD), metabolic syndrome, obstructive sleep apnea, cardiovascular diseases, and specific malignancies.[3,4] Type 2 diabetes, one of the most common consequences of obesity, is strongly linked to elevated BMI, with approximately 90% of individuals diagnosed with T2DM being overweight or obese.[5]

The management of morbid obesity relies on three primary pillars: lifestyle modification (including nutritional therapy and physical activity), pharmacotherapy, and bariatric surgery. While non-surgical approaches frequently yield limited long-term success in maintaining weight loss and controlling metabolic disturbances, bariatric surgery is recognized as the most definitive therapeutic intervention for patients with morbid obesity.[6] These surgical procedures not only induce substantial and sustained weight loss but also lead to significant improvement or remission of metabolic disorders, particularly T2DM.[7]

Sleeve gastrectomy (SG) and mini gastric bypass (MGB), also known as one-anastomosis gastric bypass (OAGB), are widely used bariatric procedures. SG is primarily a restrictive procedure involving the longitudinal resection of approximately 70–80% of the stomach along the greater curvature. In contrast, MGB is a hybrid technique (both restrictive and malabsorptive) that entails creating a long, narrow gastric tube with an antecolic loop gastrojejunostomy, thereby bypassing a substantial segment of the proximal intestine.[8]

Despite extensive literature comparing these two modalities, controversy persists regarding their relative efficacy in glycemic control and the resolution of metabolic comorbidities. Certain investigations have reported superior outcomes with MGB regarding glycemic indices[9], whereas others have found no statistically significant differences between the two approaches.[10] These conflicting findings underscore the need for well-designed cohort studies to further clarify comparative outcomes.

Accordingly, the present study was undertaken to compare the efficacy of MGB versus SG in promoting weight loss and improving metabolic comorbidities in patients with morbid obesity.

Materials and Methods

This prospective, longitudinal cohort study was designed and conducted to compare the efficacy of MGB and SG in improving anthropometric parameters, metabolic profiles, and clinical outcomes among patients with morbid obesity. The study population included all consecutive patients with morbid obesity (defined as a BMI≥40 kg/m2 or a BMI≥35 kg/m2 in the presence of obesity-related comorbidities) who underwent either SG or MGB during 2024 at Imam Reza Educational, Research, and Medical Center and Bistoon Subspecialty Hospital, both affiliated with Kermanshah University of Medical Sciences. To eliminate inter-operator variability and minimize performance bias, all surgical procedures were performed by a single, experienced laparoscopic bariatric surgeon using standardized operative protocols.

The sample size was determined based on the study by Mehdi et al. [11], considering the improvement rates of metabolic parameters. Using Cochran's formula for comparing two independent proportions, with a two-sided significance level of 5% (α=0.05), a statistical power of 80% (1−β=0.80), and accounting for potential loss to follow-up, the required sample size was calculated as 80 patients per surgical arm (N=160 in total). Inclusion criteria were: age between 18 and 65 years,

diagnosis of morbid obesity meeting bariatric surgery criteria, elective primary MGB or SG, and the presence of at least one baseline metabolic comorbidity (dyslipidemia, T2DM, or systemic hypertension). Exclusion criteria included a previous history of bariatric or extensive upper gastrointestinal surgery, occurrence of major postoperative complications requiring emergency surgical re-intervention, development of malignant neoplasms during the study period, pregnancy, and non-compliance with scheduled postoperative follow-up protocols. Demographic characteristics (age and sex), anthropometric variables, laboratory parameters, and clinical outcomes were recorded prospectively at predetermined intervals.

Body weight (kg) was recorded at four distinct time points: preoperatively (baseline) and at 1, 3, and 9 months postoperatively. Weight loss outcomes were quantified by absolute weight loss (kg) and total weight loss percentage (%TWL) at 9 months postoperatively, calculated as follows:

$$TWL\% = \frac{Baseline\,Weight - Month\,9\,Weight}{Baseline\,Weight} \times 100$$

Metabolic and Hemodynamic Parameters

The following parameters were measured at baseline and at month 9: serum triglycerides (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), fasting blood glucose (FBS), and systolic blood pressure (SBP). Both absolute and percentage changes relative to baseline were calculated.

Clinical Outcomes

Hepatic steatosis grade (ranging from 0 to 3, evaluated via abdominal ultrasonography by an experienced radiologist) and the presence of musculoskeletal pain were evaluated during follow-up visits. Statistical analyses were performed using SPSS software (version 26.0; IBM Corp., Armonk, NY, USA). Continuous variables are expressed as mean ± standard deviation (SD), and categorical variables are presented as absolute frequencies and percentages (n, %). The normality of continuous distributions across group-by-time combinations was evaluated using the Shapiro–Wilk test. Baseline demographic comparability between the two cohorts was assessed using independent-samples t-tests for continuous variables and the Chi-square ($\chi 2$) test for categorical variables. To assess the main effects of surgical approach (between-subject factor), time (within-subject factor), and their interaction (time × group), a repeated measures analysis of variance (RM-ANOVA) was conducted. Homogeneity of variances across groups was verified using Levene's test, and equality of covariance matrices was tested using Box's M test. The assumption of sphericity was evaluated using Mauchly's test; where sphericity was violated, degrees of freedom were adjusted using the Greenhouse–Geisser correction. Pairwise comparisons across time points were performed using Bonferroni-adjusted post-hoc tests. Effect sizes were estimated using partial eta squared ($\eta p2$), alongside observed statistical power. Changes in ordinal and categorical variables over time and between groups were analyzed using Fisher's exact test or the Chi-square test, as appropriate. A two-tailed p-value of less than 0.05 was considered statistically significant for all tests.

Results

A total of 160 patients with morbid obesity undergoing bariatric surgery were evaluated, divided into two equal cohorts of 80 patients each: the MGB group and the SG group. The mean age was significantly higher in the MGB cohort (39.45±8.63 years) than in the SG cohort (25.64±7.93 years; p=0.001). Sex distribution did not differ significantly between the two groups: the SG group included 39 males (48.7%) and 41 females (51.3%), whereas the MGB group comprised 34 males (42.5%) and 46 females (57.5%; p=0.189).

Table 1. Assessment of Statistical Assumptions for Repeated Measures Analysis of Variance Models

Parameter	**Shapiro Wilk Stat*	*Normality P-value*	*Levene's Stat*	*Homogeneity P-value*	*Box's M Stat*	*Box's M P-value*
Baseline Weight	*0.972*	*0.214*	*0.684*	*0.411*	*8.45*	*0.218*
Month 1 Weight	*0.965*	*0.138*	*1.126*	*0.295*		
Month 3 Weight	*0.978*	*0.287*	*0.438*	*0.510*		
Month 9 Weight	*0.969*	*0.176*	*1.842*	*0.181*		
Baseline Triglycerides	*0.951*	*0.171*	*0.927*	*0.338*	*1.82*	*0.412*
Month 9 Triglycerides	*0.963*	*0.124*	*1.574*	*0.214*		
Baseline HDL-C	*0.976*	*0.263*	*0.362*	*0.550*	*3.41*	*0.185*
Month 9 HDL-C	*0.981*	*0.391*	*0.718*	*0.399*		
Baseline LDL-C	*0.958*	*0.096*	*1.263*	*0.266*	*2.14*	*0.347*
Month 9 LDL-C	*0.971*	*0.205*	*0.584*	*0.448*		
Baseline Total Cholesterol	*0.967*	*0.153*	*0.846*	*0.365*	*0.950*	*0.628*
Month 9 Total Cholesterol	*0.974*	*0.238*	*1.097*	*0.301*		
Baseline Fasting Blood Glucose	*0.944*	*0.152*	*2.016*	*0.161*	*4.89*	*0.091*
Month 9 Fasting Blood Glucose	*0.968*	*0.161*	*1.386*	*0.245*		
Baseline Systolic BP	*0.970*	*0.092*	*2.810*	*0.143*	*1.64*	*0.443*
Month 9 Systolic BP	*0.918*	*0.142*	*1.156*	*0.285*		

*The Shapiro–Wilk test was performed to assess the normality of distributions across all combinations of surgical groups and assessment time points.

HDL-C: High-Density Lipoprotein Cholesterol; LDL-C: Low-Density Lipoprotein Cholesterol; BP: Blood Pressure.

Evaluation of RM-ANOVA assumptions confirmed a normal distribution for all continuous variables, as indicated by the Shapiro – Wilk test ($P > 0.05$). Levene's test confirmed homoscedasticity across all assessment intervals ($P > 0.05$), and Box's M test confirmed the equality of variance-covariance matrices ($P > 0.05$). Since Mauchly's test indicated a violation of sphericity for body weight ($P < 0.001$), the Greenhouse – Geisser correction (ϵ=0.784) was applied for within-subject comparisons (Table 1).

Table 2. Results of Repeated Measures Analysis of Variance (RM-ANOVA) for Time, Surgical Group, and Time × Group Interaction Effects

*Variable**	*Source of Variation*	*Mean Square*	*F - statistic*	*P -value*	*Partial η^2*	*Observed Power*
*Weight***	*Time*	*48620.1*	*1482.6*	*< 0.001*	*0.904*	*1.000*
	Time × Group	*163.9*	*5.00*	*0.004*	*0.031*	*0.842*
	Group	*215.8*	*0.58*	*0.447*	*0.004*	*0.118*
Triglycerides	*Time*	*124310.5*	*398.2*	*< 0.001*	*0.716*	*1.000*
	Time × Group	*4248.3*	*13.60*	*< 0.001*	*0.079*	*0.956*
	Group	*4821.1*	*3.54*	*0.062*	*0.022*	*0.463*
HDL-C	*Time*	*23450.8*	*582.4*	*< 0.001*	*0.787*	*1.000*
	Time × Group	*312.5*	*7.76*	*0.006*	*0.047*	*0.789*
	Group	*120.4*	*1.85*	*0.176*	*0.012*	*0.272*
LDL-C	*Time*	*124800.2*	*298.5*	*< 0.001*	*0.654*	*1.000*
	Time × Group	*1058.0*	*2.53*	*0.114*	*0.016*	*0.352*
	Group	*850.2*	*0.81*	*0.369*	*0.005*	*0.145*
Total Cholesterol	*Time*	*118542.0*	*354.1*	*< 0.001*	*0.691*	*1.000*
	Time × Group	*4826.4*	*14.40*	*< 0.001*	*0.084*	*0.965*
	Group	*2415.0*	*1.72*	*0.191*	*0.011*	*0.256*
Fasting Blood Glucose	*Time*	*91250.0*	*312.4*	*< 0.001*	*0.664*	*1.000*
	Time × Group	*3850.2*	*13.18*	*< 0.001*	*0.077*	*0.950*
	Group	*28540.0*	*42.15*	*< 0.001*	*0.211*	*1.000*
Systolic BP	*Time*	*65210.4*	*388.9*	*< 0.001*	*0.711*	*1.000*
	Time × Group	*382.1*	*2.28*	*0.133*	*0.014*	*0.323*
	Group	*112.5*	*0.54*	*0.463*	*0.003*	*0.113*

*Values are presented as F-statistic, p-values, partial eta squared (η_p^2), and observed statistical power.

**Due to a violation of sphericity in body weight measurements, the Greenhouse–Geisser correction was applied.

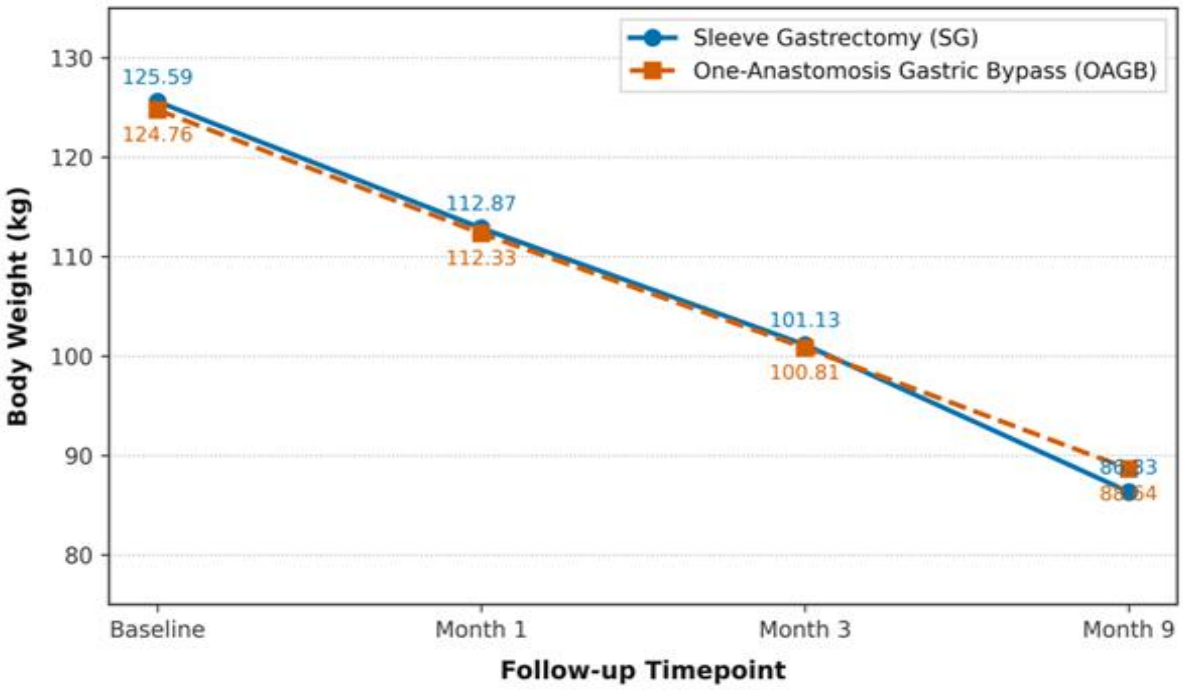


Figure 1. Profile plots illustrating mean body weight trajectories across follow-up intervals (baseline, month 1, month 3, and month 9), stratified by surgical procedure (Sleeve Gastrectomy vs. Mini Gastric Bypass).

Table 3. Comparison of Body Weight Trajectories Between Sleeve Gastrectomy and Mini Gastric Bypass Cohorts at Baseline and at 1, 3, and 9 Months Postoperatively

Assessment Time Point	*Sleeve Gastrectomy (Mean±SD)*	*Mini Gastric Bypass (Mean±SD)*	*P-value*
Preoperative Weight (kg)	*125.59±19.75*	*124.76±21.68*	*0.745*
Month 1 Postoperative (kg)	*112.87±15.65*	*112.33±19.53*	*0.859*
Month 3 Postoperative (kg)	*101.13±15.27*	*100.81±18.26*	*0.730*
Month 9 Postoperative (kg)	*86.33±13.79*	*88.64±15.99*	*0.381*
Absolute Weight Loss from Baseline to Month 9 (kg)	*39.26±5.98*	*36.12±5.74*	*0.068*
Percentage Total Weight Loss (%TWL) at Month	*31.26±4.75%*	*28.95±4.58%*	*0.002*

Table 4. Pairwise Comparisons of Weight Loss (kg) Across Consecutive Follow-Up Intervals Using the Bonferroni Post-Hoc Test

Surgical Group	*Pairwise Interval Comparison*	*Mean Difference (kg)*	*Standard Error*	*Adjusted p-value*	*95% Confidence Interval*
Sleeve Gastrectomy	*Baseline vs. Month 1*	*12.72*	*0.48*	*< 0.001*	*11.43 – 14.01*
	Month 1 vs. Month 3	*11.74*	*0.42*	*< 0.001*	*10.61 – 12.87*
	Month 3 vs. Month 9	*14.80*	*0.56*	*< 0.001*	*13.29 – 16.31*
	Baseline vs. Month 9	*39.26*	*0.67*	*< 0.001*	*37.46 – 41.06*
Mini Gastric Bypass	*Baseline vs. Month 1*	*12.43*	*0.51*	*< 0.001*	*11.06 – 13.80*
	Month 1 vs. Month 3	*11.52*	*0.45*	*< 0.001*	*10.31 – 12.73*
	Month 3 vs. Month 9	*12.17*	*0.58*	*< 0.001*	*10.61 – 13.73*
	Baseline vs. Month 9	*36.12*	*0.64*	*< 0.001*	*34.40 – 37.84*

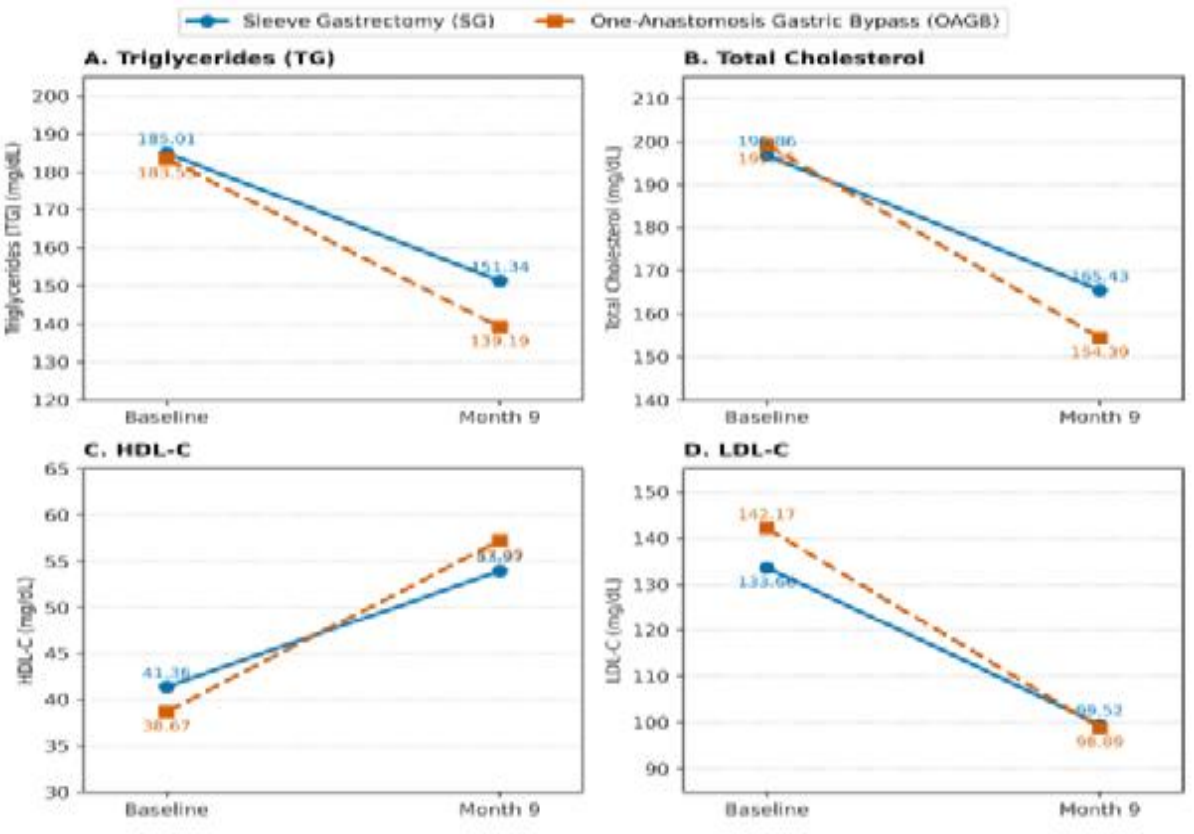


Figure 2. Profile plots demonstrating changes in mean serum lipid profile parameters (triglycerides, HDL-C, LDL-C, and total cholesterol) from baseline to month 9 postoperatively, stratified by surgical procedure.

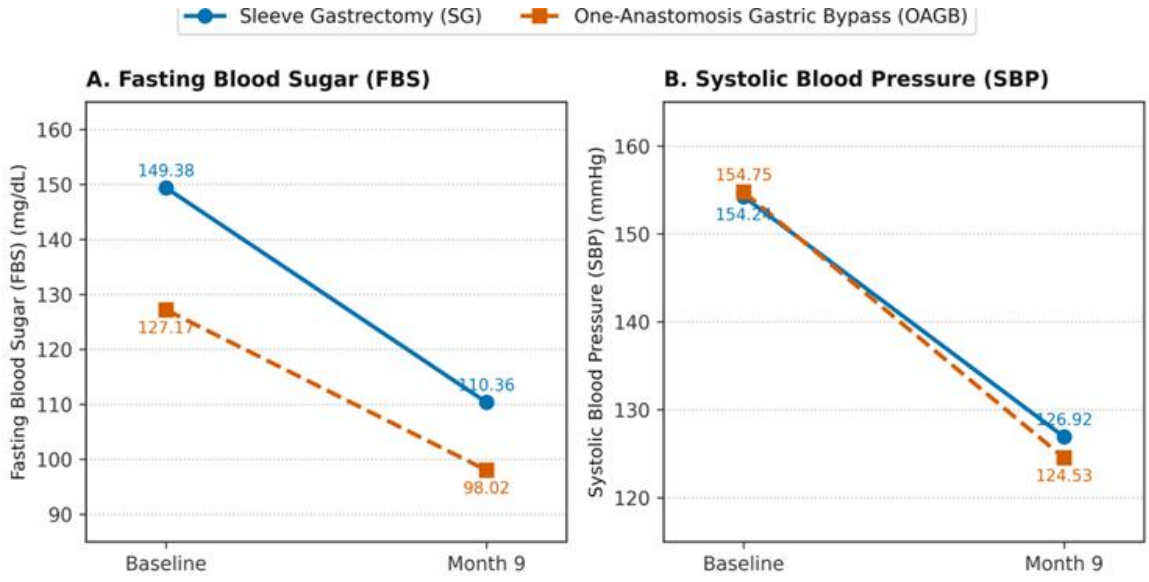


Figure 3. Profile plots depicting changes in mean fasting blood glucose (mg/dL) and systolic blood pressure (mmHg) from baseline to month 9 postoperatively, stratified by surgical procedure.

Body weight demonstrated a significant progressive reduction over time in both surgical cohorts (p<0.001). A significant time × surgical group interaction effect was observed (p=0.004), indicating distinct temporal trajectory profiles between the groups, despite the overall main effect of surgical group was not statistically significant (p=0.447) (Table 2, Figure 1).

Although the absolute weight loss from baseline to month 9 did not reach statistical significance between the two modalities (p=0.068), the total weight loss percentage (%TWL) was significantly higher in the SG cohort than in the MGB cohort (p=0.002) (Table 3). Bonferroni post-hoc comparisons demonstrated that weight reduction was statistically significant across all consecutive assessment intervals within each group (baseline to month 1, month 1 to month 3, month 3 to month 9, and baseline to month 9; all p<0.001) (Table 4).

Repeated measures analysis over the 9-month follow-up period showed significant decreases in mean serum triglycerides, LDL-C, total cholesterol, FBS, and systolic blood pressure, alongside a significant elevation in HDL-C in both cohorts (main effect of time: p<0.001 for all parameters) (Table 2, Figures 2 and 3).

A significant interaction effect between time and surgical group was observed for triglycerides, HDL-C, and total cholesterol (p<0.01). Specifically, the magnitude and percentage improvement of these three lipid parameters at month 9 were significantly greater in the MGB group compared to the SG group (p<0.05). In contrast, no significant time × group interaction was observed for LDL-C or systolic blood pressure, with both procedures demonstrating comparable reductions (p>0.05). Although the interaction effect was significant for fasting blood glucose (p=0.001), reflecting a larger absolute decline in the SG group (p=0.001), the percentage reduction in FBS showed no statistically significant difference between the two surgical groups (p=0.205) (Tables 2 and 5).

Table 5. Comparison of Metabolic and Hemodynamic Parameters between Surgical Cohorts at Baseline and Month 9 postoperatively

Parameter	*Assessment Point*	*Sleeve Gastrectomy (Mean±SD)*	*Mini Gastric Bypass (Mean±SD)*	*P -value*
Triglycerides (mg/dL)	*Preoperative*	*185.01±43.23*	*183.53±43.65*	*0.796*
	Month 9	*151.34±38.01*	*139.19±38.05*	*0.016*
	Absolute Reduction	*34.29±19.21*	*44.60±28.10*	*0.001*
	Percentage Reduction (%)	*18.53±10.38%*	*24.28±15.30%*	*0.006*
HDL-C (mg/dL)	*Preoperative*	*41.36±13.60*	*38.67±6.46*	*0.056*
	Month 9	*53.97±11.05*	*57.25±8.56*	*0.012*
	Absolute Reduction	*15.70±5.80*	*18.57±6.29*	*0.001*
	Percentage Reduction (%)	*38.01±14.15%*	*48.04±16.32%*	*0.001*
LDL-C (mg/dL)	*Preoperative*	*133.66±44.92*	*142.17±53.83*	*0.113*
	Month 9	*99.52±21.44*	*98.89±25.19*	*0.839*
	Absolute Reduction	*35.70±29.58*	*43.08±28.40*	*0.054*
	Percentage Reduction (%)	*26.71±22.13%*	*30.30±19.98%*	*0.282*
Total Cholesterol (mg/dL)	*Preoperative*	*196.86±44.85*	*199.35±38.10*	*0.649*
	Month 9	*165.43±38.24*	*154.39±38.47*	*0.029*
	Absolute Reduction	*32.48±18.32*	*44.61±28.28*	*0.001*
	Percentage Reduction (%)	*16.50±9.31%*	*22.37±14.19%*	*0.002*
Fasting Blood Glucose (mg/dL)	*Preoperative*	*149.38±44.41*	*127.17±22.42*	*0.001*
	Month 9	*110.36±33.15*	*98.02±10.59*	*0.001*
	Absolute Reduction	*39.02±26.09*	*29.15±17.88*	*0.001*
	Percentage Reduction (%)	*26.12±17.47%*	*22.92±14.05%*	*0.205*
Systolic BP (mmHg)	*Preoperative*	*154.24±24.64*	*154.75±17.67*	*0.857*
	Month 9	*126.92±14.61*	*124.53±12.66*	*0.186*
	Absolute Reduction	*27.15±16.55*	*30.19±13.82*	*0.131*
	Percentage Reduction (%)	*17.58±10.72%*	*19.51±8.94%*	*0.217*

Table 6. Comparative Preoperative and Postoperative Changes in Hepatic Steatosis Grade Between Surgical Approaches

Hepatic Steatosis Grade	*Sleeve Gastrectomy Preoperative*	*Sleeve Gastrectomy Postoperative*	*Mini Gastric Bypass Preoperative*	*Mini Gastric Bypass Postoperative*
Grade 0	*0 (0/0%)*	*13 (16/2%)*	*0 (0/0%)*	*14 (17/5%)*
Grade 1	*11 (13/7%)*	*47 (58/8%)*	*8 (10/0%)*	*53 (66/3%)*
Grade 2	*37 (46/3%)*	*20 (25/0%)*	*42 (52/5%)*	*13 (16/2%)*
Grade 3	*32 (40/0%)*	*0 (0/0%)*	*30 (37/5%)*	*0 (0/0%)*
Within-Group p-value	*-*	*< 0/001*	*-*	*< 0/001*

Table 7. Evolution and Resolution Rates of Musculoskeletal Pain across Follow-Up Time Points

Assessment Time Point	*Sleeve Gastrectomy: Active Pain (n)*	*Sleeve Gastrectomy: Pain Resolution (%)*	*Mini Gastric Bypass: Active Pain(n)*	*Mini Gastric Bypass: Pain Resolution (%)*	*Between-Group p-value*
Preoperative	*36*	*0/0%*	*32*	*0/0%*	*1/000*
Month 1 Postoperative	*28*	*22/2%*	*23*	*28/1%*	*0/852*
Month 3 Postoperative	*4*	*88/9%*	*9*	*72/0%*	*0/093*
Month 9 Postoperative	*0*	*100/0%*	*0*	*100/0%*	*1/000*

Hepatic steatosis grade showed significant improvement by month 9 compared to baseline in both cohorts (p=0.001). Notably, grade 3 steatosis was completely eliminated in both groups, with the majority of patients shifting to grades 0 and 1 (Table 6). Furthermore, the prevalence of musculoskeletal pain progressively decreased over time in both cohorts. Resolution rates at months 1 and 3 showed no significant differences between the two groups (p>0.05), and by month 9, complete remission (100%) of musculoskeletal symptoms was achieved in all patients across both groups (p=1.000) (Table 7).

Discussion

The findings of this prospective cohort study demonstrate that both SG and MGB induce significant weight loss, as well as comprehensive improvements in metabolic abnormalities over a 9-month postoperative period. These results reinforce the established role of bariatric surgery as the most definitive therapeutic intervention for patients with morbid obesity. Nevertheless, notable differences emerged between the two surgical techniques regarding the magnitude and temporal patterns of anthropometric and metabolic improvements, which have important clinical implications.

Regarding our primary anthropometric endpoint, both surgical groups demonstrated continuous weight loss at all follow-up time points, with a significant time-by-procedure interaction. Although the total absolute weight reduction at month 9 was comparable between the two groups, the standardized percentage of total weight loss (%TWL) revealed that patients undergoing SG achieved greater relative weight reduction than those undergoing MGB. This finding is concordant with the broader meta-analytic evidence synthesized by Buchwald et al., which demonstrated that modern bariatric interventions achieve robust short- and mid-term weight loss, with standardized metrics relative to baseline mass providing superior sensitivity in delineating procedural differences.[12,13]

Regarding glycemic parameters, both surgical interventions led to significant reductions in FBS from baseline to month 9. Although the absolute decrease in FBS was more pronounced in the SG group—partly attributable to their higher baseline glucose levels—the relative percentage reduction did not differ significantly between the two groups. This parity contrasts somewhat with previous studies that reported distinct superiority of bypass procedures in glycemic control.[14,15] The comparable glycemic efficacy observed here may be explained by the profound suppression of ghrelin secretion following resection of the gastric fundus in SG, combined with rapid loss of visceral adiposity and early restoration of peripheral insulin sensitivity, as established in metabolic and physiological literature.[16]

With respect to systemic blood pressure, both procedures resulted in equivalent and significant reductions in systolic blood pressure over time, without significant differences between groups. This finding is consistent with the results reported by Ammar et al. and Persson et al., indicating that blood pressure normalization following bariatric surgery is primarily dependent on weight loss and occurs largely independent of the type of anatomical reconstruction.[17,18] The mechanisms underlying this shared benefit include hemodynamic unloading, downregulation of the renin-angiotensin-aldosterone axis, and suppression of systemic vascular inflammation.[19]

Distinct advantages emerged when evaluating lipid homeostasis. MGB demonstrated clear superiority over SG in reducing serum triglycerides, lowering total cholesterol, and increasing HDL-C levels, while changes in LDL-C remained comparable between the two groups. These findings align with observations by Georgiadou et al.[14] and Piazza et al.[20],who highlighted the more potent metabolic impact of procedures incorporating an intestinal bypass element on lipid metabolism.[9,11] Bypassing the proximal small bowel, altering enterohepatic bile acid circulation, and modulating incretin and gut hormone profiles in MGB exert additive metabolic effects on lipid metabolism beyond weight reduction alone.

Regarding NAFLD, both surgical modalities induced substantial regression of hepatic steatosis, completely clearing grade 3 disease and transitioning most patients to mild or resolved states, with no significant difference between groups. This observation aligns with Bray et al., who underscored that the rapid depletion of intrahepatic lipid content and resolution of lipotoxicity fundamentally result from sustained negative energy balance and reduction in visceral fat, regardless of whether a purely restrictive or hybrid approach is used.[21]

Finally, the progressive resolution of musculoskeletal pain, culminating in complete remission in both groups by month 9, reflects the relief of joint biomechanical

loading and a decrease in circulating pro-inflammatory adipokines. This finding is consistent with previous reports on musculoskeletal quality-of-life recovery following bariatric surgery.[22]

Limitations

Several limitations of this study warrant consideration. First, treatment allocation was non-randomized due to clinical indications and surgeon-patient decision-making, resulting in baseline age differences between the cohorts. Second, the 9-month follow-up represents a mid-term evaluation. Future large-scale randomized controlled trials with extended follow-up periods (≥2 to 5 years) are recommended to evaluate the long-term durability of these metabolic and anthropometric improvements and to monitor potential late nutritional sequelae.

Conclusion

Both SG and MGB are highly effective interventions for inducing significant weight loss and improving metabolic comorbidities in patients with morbid obesity. However, the two techniques exhibit distinct clinical advantages: SG achieves superior percentage total weight loss (%TWL), whereas MGB demonstrates greater efficacy in correcting dyslipidemia by reducing triglycerides and total cholesterol and elevating HDL-C. Both procedures are equally effective in reducing systolic blood pressure, reversing hepatic steatosis, and resolving musculoskeletal pain. Therefore, the choice of procedure should be individualized, primarily based on whether the patient's main therapeutic priority is maximal weight reduction or targeted correction of severe dyslipidemia.

Recommendations

1. Personalized Surgical Algorithms: Develop tailored clinical decision pathways that prioritize MGB for patients with severe, refractory atherogenic dyslipidemia, and SG for individuals whose primary goal is maximizing percentage total weight loss.
2. Long-Term Prospective Trials: Conduct multi-center, randomized controlled trials with long-term follow-up (exceeding two years) to evaluate the long-term stability of metabolic remission and to assess late nutritional and micronutrient parameters.
3. Enterohormonal Mechanistic Studies: Integrate assessments of circulating incretins, bile acid subfractions, and gut microbiome profiles in future trials to further delineate the precise physiological mechanisms underlying procedural differences.

Conflict of Interest

The authors declare that they have no competing interests.

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