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Original Article

Short Term outcome of Laparoscopic Sleeve Gastrectomy versus Gastric Bypass on Body Weight and Common Associated Comorbidities: Randomized Controlled Study

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Abstract

Background: Laparoscopic Roux en Y gastric bypass (LRYGB) is a hybrid procedure that combines gastric restriction with gastrectomy and malabsorption, whereas laparoscopic sleeve gastrectomy (LSG) is a restrictive method often used initially for patients with severe obesity.
Methods: This prospective randomized controlled trial involved 80 patients between 18 to 65 years . The study included patients with a body mass index (BMI) of ≥40 kg/m2, with or without medical comorbidities, and those with a ≥BMI of 35 kg/m2 accompanied by obesity-related comorbidities. The participants were randomly assigned into two groups: Group I, consisting of 40 patients who underwent Laparoscopic Sleeve Gastrectomy (LSG), and Group II, comprising 40 patients who received Laparoscopic Roux en Y Gastric Bypass (LRYGB).
Results: The percentages of total and excess weight loss after 3, 6 months, and 1 year showed no significant differences between the two groups. Improvements in hypertension, type II diabetes, and dyslipidemia were more pronounced in the group II than group I. Regarding nutritional status; serum iron, ferritin A, and calcium levels were significantly lower at 3, 6 months, and 1 year in group II compared to group I (P value < 0.05).
Conclusions: Sleeve gastrectomy and gastric bypass are equally effective in terms of excess weight loss and total body weight loss after one year. While LSG shows more favorable results in preserving nutritional status one-year post-surgery, LRYGB is more effective in resolving comorbidities like hyperlipidemia, diabetes mellitus, and hypertension

Keywords: Laparoscopic Sleeve Gastrectomy, Roux-en-Y Gastric Bypass, Obesity.

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Introduction:

When compared to non-surgical treatments, bariatric surgery is the most effective therapy for morbid obesity. Sustained weight loss, improvements in obesity-related comorbidities, and an overall higher quality of life are the main benefits of this operation. (1) Laparoscopic sleeve gastrectomy (LSG), laparoscopic Roux-en-Y gastric bypass (RYGB), laparoscopic biliopancreatic diversion with (BPD-DS) or without duodenal switch, and single-anastomosis gastric bypass are among the surgical methods that are now accessible. (2)

By avoiding the duodenum and proximal jejunum, the laparoscopic Roux en Y gastric bypass is a hybrid operation that combines malabsorption with gastric restriction, gastrectomy, and other procedures. Before moving on to a malabsorptive treatment, patients with extreme obesity (body mass index (BMI) >50 kg/m2) are first treated with the restrictive technique known as laparoscopic sleeve gastrectomy (LSG) . (3)

Similar results have been obtained from both bariatric surgical techniques in terms of weight loss, improved glucose metabolism, significant changes in hypertension, serum cholesterol levels, nutritional status, and decreased risk of cardiovascular disease. (4) The only long-term, effective therapy for obese people who have high cardiovascular risk death rates is bariatric surgery. (5)

The purpose of this research was to assess the efficacy of laparoscopic gastric bypass and laparoscopic sleeve gastrectomy as bariatric surgical techniques for the treatment of morbid obesity. It compared how they affected body weight and common co-occurring conditions such Type II diabetes, hypertension, and hyperlipidemia.

Patients and Methods

After receiving approval from our institution's ethical committee, a prospective randomized controlled study was carried out for obese patients undergoing laparoscopic bariatric surgery in the general surgery department of Sohag University Hospital. All patients were asked to provide informed written consent for their participation in the study. The research was carried out from 2017 to 2022. Following an eligibility assessment, 80 patients were divided into two equal groups of 40 patients each: the sleeve group and the Roux-en-Y Gastric Bypass group.

Preoperative preparation:

For two weeks before to surgery, all patients were required to adhere to a unique preoperative diet known as the "liver shrinkage diet," which consists of a high-protein, low-carb, and fat-free diet. It was advised to stop smoking four weeks before to surgery. Preoperative psychological testing includes a personality analysis in addition to tests of expectancy and motivation, past food intake, and way of life. The day before to surgery, an anesthesiologist performed a pre-anesthesia examination.

Operative modalities:

Surgical options in the current study were LSG and laparoscopic Roux-en-Y Gastric Bypass.

Surgical Technique

Under general anesthesia the patients were positioned in a 30° anti-Trendelenburg position with legs abducted (French position). Both legs were supported and secured with a belt and tape. The surgeon stands between both legs, whereas the first assistant, holding the camera, is on the left side of the surgeon. A second assistant is placed on the right side of the surgeon. Abdominal entry was established using the closed method (Veress Needle). Pneumoperitoneum was created (15 mmHg). First, a mid-line supraumbilical incision (10 mm first port) 15 cm below the xiphisternum was done. A 30° angled scope was introduced, and the abdomen was inspected, then an epigastric port (10 mm) through which the liver retractor was introduced. Other two (12 mm) optical trocars included one in the left midcla-vicular line beneath the left rib arch and the other in the right midclavicular line beneath the right rib arch. Last, a 5-mm port in the left anterior axillary line is used for the assistant.

Laparoscopic Sleeve Gastrectomy (LSG):

In order to fully expose the left crus, the stomach greater curvature was mobilized starting 6 cm proximal to the pylorus and continuing to the angle of His. During the stomach resection, Johnson and Johnson Staplers' vertical 60 mm staple cartridges (Echelon Flex®, Ethicon Endo-Surgery INC, J & J Medical SPA, Somerville, NJ, USA) were used over a 36-Fr bougie. The blue cartridge was the last one to be used. Applying laparoscopic clips to the bleeding sites along the

staple line allowed for hemostasis to be established. After the specimen was extracted, the staple line was strengthened with 3/0 PDS continuous inverted Lambert sutures.

Roux-en-Y Gastric Bypass:
With a horizontal stapler 60 mm blue cartridge up to the left crus, the gastric tube was constructed 5-7 cm below the gastroesophageal junction. Generally, vertical Johnson and Johnson Staplers (Echelon Flex) with 60 mm staple blue cartridges were used over a 36-Fr bougie. Biliary limb formation occurs 60–80 cm downstream of the Treitz angle. Vicryl 3/0 is used in two layers to close the anastomotic hole after a 45-mm blue cartilage linear stapler is used to accomplish a side-to-side loop gastrojejunostomy. After counting the Roux limb, which is located around 120 cm from the gastrojejunostomy, the biliary limb is divided from the stoma and the jejuno-jejunostomy is carried out. closure of the mesenteric flaws at last. At the conclusion of each treatment, methylene blue was introduced through a bougie to confirm that there was no stomach leak.

Intraoperative data:
Including operative procedure, blood loss, mean operative time, intraoperative complications, and conversion to laparotomy.

Follow-up:
The initial two appointments were for wound care and to look for problems at one and two weeks after surgery. Following surgery, follow-up appointments are then set for1,3,6, and 12 months out. Anthropometric measurements were obtained during visits, weight loss percentages and total weight losses were computed, and comorbidities were examined for potential improvement or resolution.

Postoperative maintenance:
By consuming multivitamins and minerals on a regular basis, nutritional problems from bariatric surgery were prevented and treated. Through the first year, laboratory testing should be performed every six months and thereafter at least once a year. Complete blood counts, lipid profiles, HbA1c, and liver function tests—particularly albumin—should all be included in the laboratory study.
The primary outcome was the weight loss by calculating the percentage of excess weight loss (% EWL) or the percentage of excess BMI lost. The secondary outcomes were the post-operative complications (in the form of conversion to laparotomy, leakage, bleeding, or mortality) and the common comorbidity changes including Type-II Diabetes, Hypertension, Hyperlipidaemia, and gastroesophageal reflux disease. All were assessed regarding either resolution or improvement.

Statistical analysis
Statistical analysis was done by SPSS v26 (IBM Inc., Chicago, IL, USA). Quantitative variables were presented as mean and standard deviation (SD) and compared between the two groups utilizing an unpaired Student's t-test. Qualitative variables were presented as frequency and percentage (%) and were analyzed utilizing the Chi-square test or Fisher's exact test when appropriate. A two-tailed P value < 0.05 was considered statistically significant.

Results
In this study, 107 patients were assessed for eligibility, 18 patients did not meet the criteria and 9 patients refused to participate in the study. The remaining patients were randomly allocated into two equal groups (40 patients in each). All allocated patients were followed up and analyzed statistically (Figure 1)

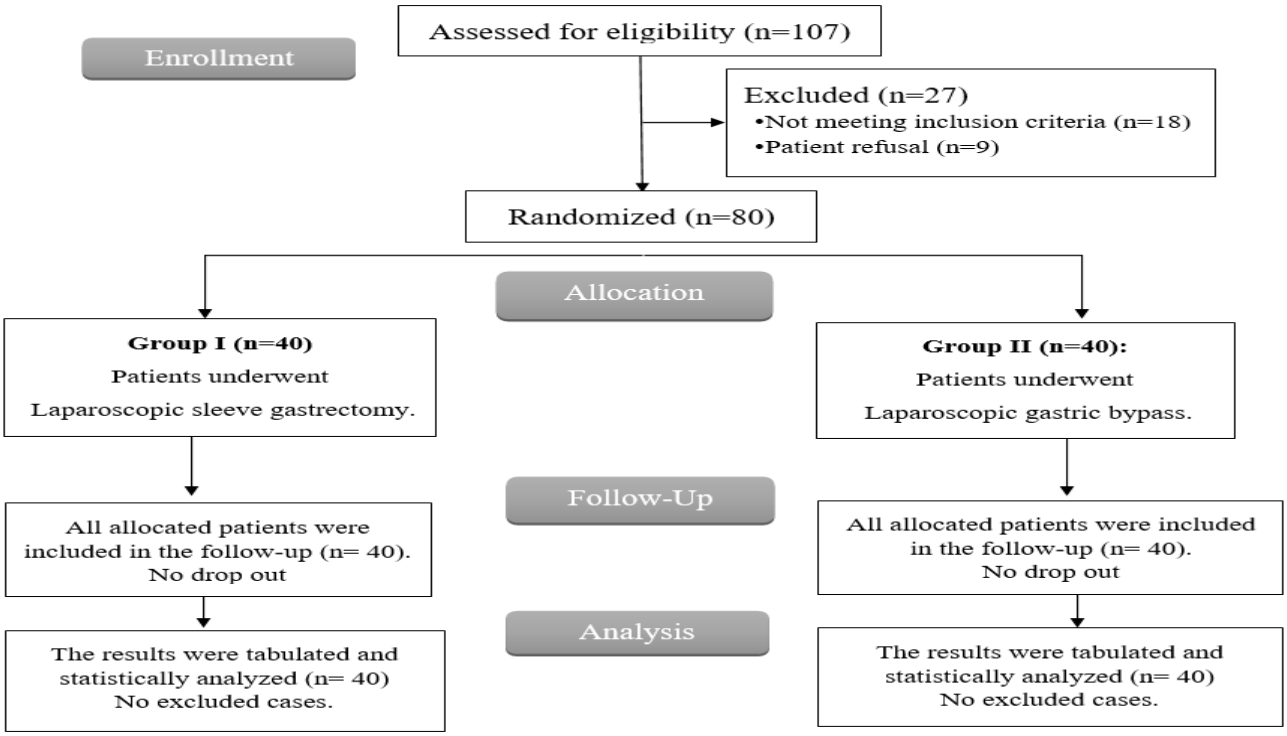

Figure 1: CONSORT flowchart of the enrolled patients

Patients' characteristics:

A total of 80 bariatric patients who underwent LSG and LRYGB between January 2017 and December 2022 in a tertiary bariatric center were analyzed. Of these, 40 patients were LSG (group I), and 40 patients were LRYGB. Preoperative patient characteristics including demographic data and comorbidities are summarized in (Table 1).

Table 1: patient characteristics

		Sleeve group (n=40)	Bypass group (n=40)	P
Age (years)		35.88 ± 8.03	34.98 ± 7.75	0.611
Sex	**Male**	20 (50%)	19 (47.5%)	0.823
	Female	20 (50%)	21 (52.5%)	
Height (cm)		163.75 ± 5.96	159.4 ± 6.62	**0.003***
Weight (kg)		121.4±12.26	122.3±5.56	0.674
BMI (kg/m^2)		46.02±6.48	45.96±6.3	0.971
Marital status	**Single**	21 (52.5%)	19 (47.5%)	0.655
	Married	19 (47.5%)	21 (52.5%)	
Comorbidities	**Hypertension**	23 (57.5%)	18 (45%)	0.263
	Diabetes type II	19 (47.5%)	16 (40%)	0.499
	Dyslipidaemia	40 (100%)	38 (95%)	0.493

Data are presented as mean ± SD or frequency (%). * Significant p value <0.05. BMI: Body mass index.

Weight loss outcomes

In the study population, the mean percentage of total weight loss (%TWL) and excess weight loss (%EWL) at one year, compared to the baseline weight before surgery, was 44.7±7.86% and 103.53±19.11% in group I, and 46.03±5.16% and 96.85±13.88% in group II, respectively (Table 2). The percentages of total and excess weight loss at 3, 6 months, and 1 year showed no significant difference between the two groups (Figures 2 and 3)

Table (2): weight loss outcomes; (Data are presented as mean ± SD or frequency (%)).

		Sleeve group (n=40)	Bypass group (n=40)	P
Hospital stays (days)		1.65 ± 0.66	1.68 ± 0.66	0.866
Time of surgery (min)		101.8 ± 15.63	120.63 ± 12.43	<0.001*
Percentage of Total Weight Loss (TWL%)	**After 3 months**	16.35±12.75	14.9±5.97	0.517
	After 6 months	28.15±11.06	28.5±5.41	0.858
	After1year	44.7±7.86	46.03±5.16	0.375
Percentage of Excess Weight Loss(EWL%)	**After 3 months**	37.45±28.76	31.53±13.72	0.243
	After 6 months	65.33±25.62	59.98±13.26	0.244
	After 1 year	103.53±19.11	96.85±13.88	0.078
Use of Drain		14 (35%)	17 (42.5%)	0.491

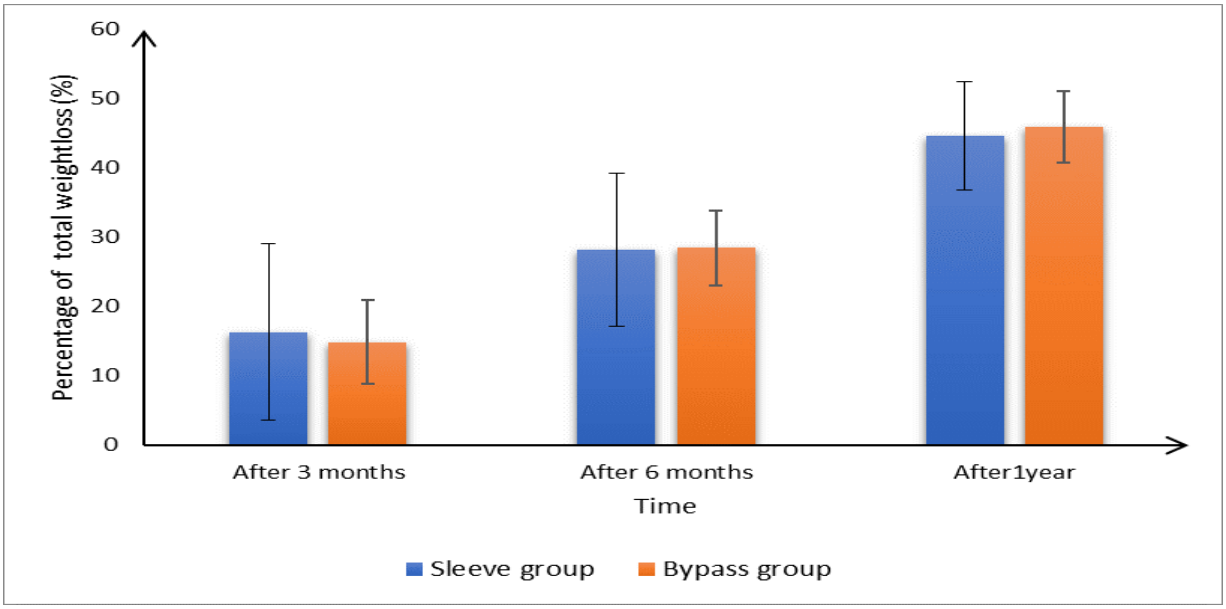

Figure 2: Percentage of total weight loss of the studied groups

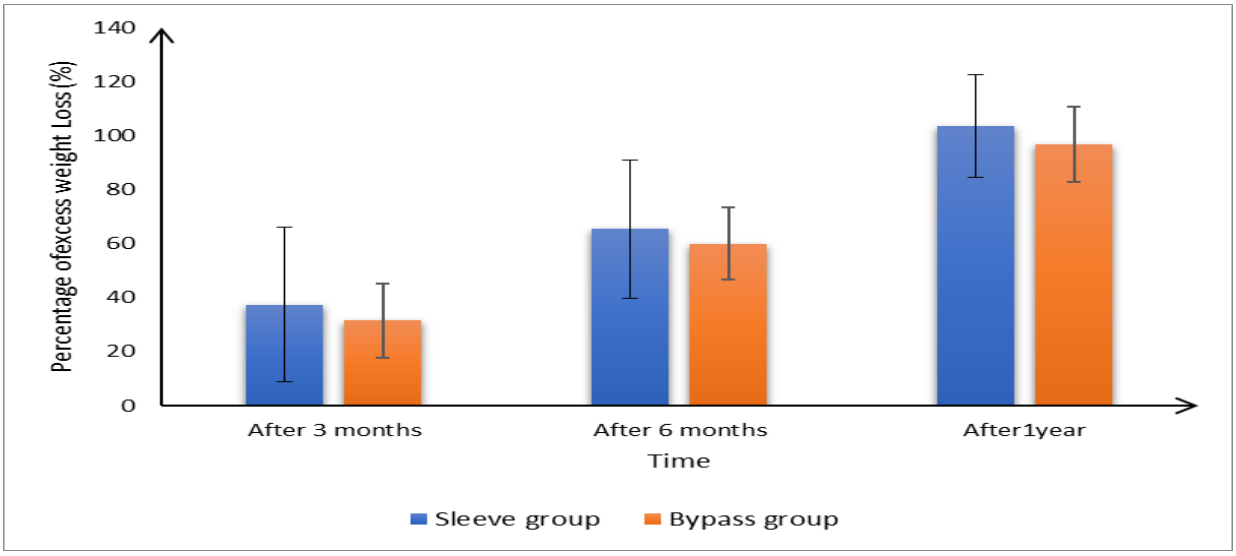

Figure 3: Percentage of excess weight loss of the studied groups

Comorbidity resolution:
The Roux en Y gastric bypass group showed superior comorbidity resolution, particularly in hyperlipidaemia (81.6% compared to 75% in the sleeve gastrectomy group) and diabetes mellitus (81.3% versus 63.2% for the sleeve group), followed by hypertension (72.2% versus 39.1% for the sleeve group). All diabetic patients who experienced resolution met the criteria set forth by the Diabetes Surgery Summit II (DSS II). [6] Three categories were used to categorise a patient's comorbidity status: resolution (if the patient stopped taking all medications), improvement (if the patient continues to take medication to control the comorbidity but uses fewer prescriptions or dosages), and no change. Table 3 displays the comorbidity numbers and percentages for both groups, along with their resolution and improvement status.

Table 3: Comorbidities resolutions of the studied groups (Data are presented as frequency (%)

		Sleeve group (n=40)	Bypass group (n=40)
Preoperative hypertensive patients		23 (57.5%)	18 (45%)
Postoperative status of hypertensive patients	**Improvement**	10 (43.5%)	3 (16.7%)
	Resolution	9 (39.1%)	13 (72.2%)
	No change	4(17.4%)	2(11.1%)
Preoperative diabetic patients		19 (47.5%)	16 (40%)
Postoperative status of diabetic patients	**Improvement**	5 (26.3%)	2 (12.5%)
	Resolution	12 (63.2%)	13 (81.3%)
	No change	2(10.5%)	1(6.2%)
Preoperative patients with dyslipidaemia		40 (100%)	38 (95%)
Postoperative status of patients with dyslipidemia	**Improvement**	5 (12.5%)	5 (13.2%)
	Resolution	30 (75%)	31 (81.6%)
	No change	5(12.5%)	2(5.3%)

When comparing the nutritional status of the two groups after three, six months, and a year, there were no discernible differences in HbA1c and LDL. After three, six months, and a year, the gastric bypass group showed significantly decreased levels of iron and ferritin A (P <0.05).

Even though group II's preoperative HDL was considerably lower than group I's (P value 0.01), there was no discernible difference in HDL levels after three, six months, and a year between the two groups. Between the two groups, triglycerides did not differ statistically after three or six months, however group II's triglyceride levels were considerably lower after a year (P value 0.017). After three, six months, and a year, the gastric bypass group's calcium levels were considerably lower than those of the sleeve group (P <0.05) (Table 4).

Table 4: Laboratory investigations at 3, 6, and 12 months after surgery in both groups.

		Sleeve group (n=40)	Bypass group (n=40)	P
Hba1c %	**Preoperative**	7.03±1.25	7.25±1.32	0.435
	After 3 months	6.05±1.01	6.35±1.13	0.209
	After 6 months	5.36±0.89	5.45±0.9	0.664
	After 1 year	4.64±0.77	4.4±0.54	0.111
Iron (mcg/dL)	**Preoperative**	93.98±10.41	95.5±10.65	0.519
	After 3 months	82.75±10.06	77.35±8.87	**0.013***
	After 6 months	73.73±11.69	64.3±7.59	**<0.001***
	After 1 year	63.08±17.59	44.83±4.83	**<0.001***
Ferritin A (ng/mL)	**Preoperative**	161.15±15.69	158.28±11.78	0.357
	After 3 months	154.68±22.11	134.98±11.44	**<0.001***
	After 6 months	167±31.62	123.7±14.76	**<0.001***
	After 1 year	161.08±45.6	96.7±7.26	**<0.001***
HDL (U/L)	**Preoperative**	34.2±2.11	33.03±1.83	**0.01***
	After 3 months	36.38±2.28	35.75±1.77	0.175
	After 6 months	39.65±3.01	39.13±2.65	0.410
	After 1 year	42.95±4.26	41.6±2.72	0.095
LDL (U/L)	**Preoperative**	131.38±9.99	129.8±11.28	0.511
	After 3 months	123.45±11.97	119.85±18.06	0.297
	After 6 months	115.78±12.31	142.5±179.03	0.349
	After 1 year	100.88±13.63	95.38±12.35	0.062
Triglycerides (mg/dL)	**Preoperative**	218.85±14.84	216.78±17.3	0.566
	After 3 months	188.48±12.55	192.73±8.61	0.081
	After 6 months	161.23±14.75	161.83±13.33	0.849
	After 1 year	140.5±14.62	133.25±11.96	**0.017***
Electrolytes				
Ca (mg/dL)	**Preoperative**	10.68±1.73	10.43±1.13	0.447
	After 3 months	10.8±1.45	9.8±1.34	**0.002***
	After 6 months	10.73±1.4	9.15±1.08	**<0.001***
	After 1 year	10.63±1.85	8.78±1.05	**<0.001***

(Data are presented as mean ± SD. * Significant p value <0.05. Hba1c: Haemoglobin A1C, HDL: High-density lipoprotein, LDL: Low density lipoprotein.)

Complications

1. Early postoperative complications: Within 30 days of surgery, there were no early postoperative problems as well as all procedures were performed laparoscopically. Eight patients (10%) experienced non-specific complications in the perioperative and early postoperative periods. These included five patients with wound issues and one patient each with raised liver enzymes, poor renal function (frequent vomiting), and urinary tract infection. One patient developed a wound infection. Three patients experienced haematomas and bleeding from wounds. No patients required laparoscopic or endoscopic intervention.
2. Late complications: After 30 days following surgery, 14 patients (23.9%) experienced at least one long-term problem. Medical attention was required for two patients with iron deficiency anaemia. One patient's recurrent dumping syndrome was treated with food adjustment. Eleven individuals needed to reoperations for port site hernia (one patient from the gastric bypass group), internal herniation (2 patients from the gastric bypass group), hiatal hernia repair (one patient from the sleeve group), and seven cases needed cholecystectomy (two sleeve gastrectomy and five gastric bypass). Table 5 shows the frequency of early, late and reoperation rate in both groups.

Table 5: Early and late complications.

Complications	**Sleeve group (n=40)**	**Bypass group (n=40)**	Management
Wound complications	3	2	Medical treatment
Impaired renal function	1	-	Medical treatment
Hepatitis and elevated liver enzymes	-	1	Medical treatment
Urinary tract infection	-	1	Medical treatment
Calcular Cholecystitis	2	5	Laparoscopic cholecystectomy
GERD, Hiatal hernia repair	1	-	Laparoscopic hiatoplasty
Iron deficiency anemia	1	1	Medical treatment
Internal herniation	-	2	Laparoscopic repair of the mesenteric defect
Port site hernia	-	1	Surgical repair
Dumping syndrome	-	1	Dietary control
Reoperation rate	**3**	**8**	

Discussion

Roux en Y gastric bypass is considered the gold standard among bariatric procedures, both as a primary surgery and as a conversion option for other failed bariatric surgeries. [7] The procedure consists of two surgical modifications: reducing the stomach's volume and rerouting the consumed nutrients away from the proximal small intestine. Sleeve gastrectomy is recognized as the most prevalent bariatric surgery worldwide. Sleeve gastrectomy is the most common bariatric procedure all over the world. The current study showed that the percentage of total and excess weight loss after 3, 6m, and one year were insignificantly different between both groups. Reduction in stomach size following LSG and LRYGB involves removing a large portion of the stomach or

excluding a large part from the stomach respectively. This significantly limits the amount of food that can be consumed at one time, leading to reduced calorie intake, and hormonal changes. The surgery affects the production of various gut hormones that regulate hunger and satiety. For instance, there is a decrease in ghrelin, a hormone that stimulates appetite, which is produced in the upper part of the stomach that is removed during LSG or excluded at LRYGB. [8] In agreement with our result, Demirpolat noticed that the percentage of excess weight loss after 6 months and 1 year was insignificantly different between the LRYGB group and the LSG group. [9] On the other hand, Bhandari et al reported that total and excess weight loss were significantly higher in the LSG group than LRYGB group after 12 months. [10]

Regarding obesity-related comorbidity, gastric bypass was superior to the sleeve group in resolution percentages among the studied comorbidities. Han et al by a systematic review and meta-analysis (based on 18 studies), reported that patients who received laparoscopic sleeve gastrictomy experienced the same effectiveness in excess weight loss and fewer postoperative complications and reoperation rates than those who received Roux-en-Y gastric bypass. [11] On the other hand, Baheeg et al. noticed that Type II diabetes mellites and dyslipidaemia were insignificantly different between both groups. [12] Salminen et al. also noticed that gastric bypass was superior in resolution of dyslipidemia, Type 2 diabetes, and hypertension than sleeve gastrectomy. [13]

Bariatric surgery significantly impacts glycemic control, especially in patients with type 2 diabetes. In this study, postoperative HbA1c levels were markedly lower after one year (4.64 ± 0.77% in the sleeve gastrectomy group vs. 4.4 ± 0.54% for the gastric bypass group) compared to preoperative levels (7.03 ± 1.25 for sleeve gastrectomy vs. 7.25 ± 1.32 for gastric bypass). The surgeries' effect on HbA1c levels stems from several mechanisms: firstly, weight loss, which is a key factor in enhancing insulin sensitivity. A reduction in fat mass, particularly visceral fat, aids in reversing insulin resistance, thus decreasing blood glucose levels and HbA1c. Secondly, caloric restriction: patients immediately experience a substantial decrease in calorie intake post-surgery due to reduced stomach size and changes in the digestive system, leading to swift improvements in glucose control, even before significant weight loss is observed . [14]

Obesity is a significant risk factor for hypertension; thus, weight loss from bariatric surgery can reduce this risk. Post-surgery, there may be changes in hormones that regulate fluid balance and blood pressure, such as aldosterone and cortisol, aiding in the management of blood pressure. Additionally, losing overall body weight can lessen the heart's workload and enhance its function, further aiding in the regulation of blood pressure. [15]

Hyperlipidemia is characterized by elevated triglycerides (> 150 mg/dL), total cholesterol (> 200 mg/dL), low high-density lipoprotein cholesterol (≤ 40 mg/dL), and high low-density lipoprotein cholesterol (> 130 mg/dL). Seventy-five percent of sleeve patients and eighteen percent were able to completely resolve their hyperlipidaemia within a year and stop taking their medication. Patients with hyperlipidaemia who are severely obese see significant improvements in their lipid profiles following weight loss operations. In the current trial, HDL was considerably lower in the LRYGB group than in the LSG group at postoperative one year (P value=0.01), but it was not significantly different between the two groups after three, six months, and a year. After one year, the LRYGB group's triglycerides were significantly lower than those of the LSG group (P value=0.017), with no significant difference between the two groups at postoperative three and six months. Demirpolat et al. conducted a retrospective investigation on obese individuals with a BMI of 35 kg/m2 or above between the ages of 18 and 60, which lends support to our findings. He demonstrated that after six months and a year, there were no discernible differences in HDL and LDL between the two groups. At six months and a year, there was no discernible difference in triglycerides between the LRYGB and LSG groups. Different sample sizes, inclusion criteria, and a higher BMI in our study—45 to 46 kg/m2—all account for this discrepancy. [9]

In terms of nutritional status, the current study found that after three, six, and 12 months; the LRYGB group's blood iron, ferritin A, and calcium levels were considerably lower than those of the LSG group (P value<0.05). These results could be explained by the patient's noncompliance with post-operative supplementation as well as the

malabsorptive nature of the gastric bypass surgeries.

In terms of complications and reoperation rates, both groups' one-year follow-ups showed signify-cant gastric bypass reoperation rates. This could be explained by the high number of cholecy-stectomies performed within the first year, particularly in the gastric bypass group. Biliary cholelithiasis has been linked to a number of causes, including decreased gallbladder motility and subsequent stasis, and elevated bile choles-terol saturation index as a result of cholesterol mobilization from adipose tissues and excretion in bile. Reduced cholecystokinin secretion as a consequence of poor food transit via the gastro-duodenal route may cause gallbladder stasis. Moreover, harm from gastric bypass to the vagus nerve's hepatic branches increases the risk by changing the physiology of the gallbladder and entero-hepatic circulation.

The study's limitation is its small sample size, which may yield inconsequential results. Studies conducted across multiple centers with a larger population would provide more substantial findings. The one-year follow-up period is another study limitation that could have an impact on the findings because the primary benefit of this type of surgery is its ability to sustain optimal results longer than non-surgical weight loss alternatives.

Conclusions:

Laparoscopic sleeve gastrectomy and gastric byp-ass are equally effective in terms of excess weight loss and total body weight loss. While sleeve gastrectomy shows more favorable results in pres-erving nutritional status one-year post-surgery, laparoscopic gastric bypass is more effective in resolving comorbidities like hyperlipidemia, diab-etes mellitus, and hypertension. Nonetheless, pati-ents undergoing laparoscopic gastric bypass have a higher incidence of reoperations compared to those who have laparoscopic sleeve gastrectomy.

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Conflict of Interest: Nil

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