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Short Term Effects of Bariatric Surgeries on Renal and Hepatic Functions on Obese Morbid Patients

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ORIGINAL STUDY

Short-term effects of bariatric surgeries on renal and hepatic functions on morbidly obese patients

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Abstract

Background: **Bariatric surgery has emerged as a well-established treatment for achieving long-lasting and successful weight reduction. Roux-en-Y gastric bypass and sleeve gastrectomy (SG) are currently the most frequently done operations. This research aimed to investigate the hepatic and renal alterations following bariatric procedures, with a particular focus on SG.**

Patients and methods: **This observational prospective cohort research was performed on 100 morbidly obese individuals with BMI more than or equal to 40 kg/m^2 who underwent SG. All patients were evaluated before surgery clinically, and all laboratory investigations were done before operation as baseline, 3 months, 6 months after surgery, and after 1 year.**

Results: **Serum glutamic oxaloacetic transaminase and serum glutamic-pyruvic transaminase (SGPT) were significantly decreased after 3 and 6 months with no significant difference after 12 months than at 6 months. Bilirubin was significantly increased after 3 months than at baseline, then it was significantly decreased after 6 months than at 3 months with no significant difference after 12 months than at 6 months. Urea was significantly decreased after surgery through all time measurements. Creatinine was insignificantly different after 3 months than baseline, while a significant decrease was achieved after 6 and 12 months.**

Conclusions: **There was a significant improvement of renal and liver functions after SG in morbidly obese cases. Also, a significant improvement of lipid profile tests was observed.**

Keywords: Bariatric surgeries, Hepatic functions, Morbidly obese, Renal functions, Sleeve gastrectomy

1. Introduction

Obesity represents a global healthcare issue. It is associated with long-term impacts, such as diabetic cardiomyopathy, musculoskeletal damage, diabetic kidney disease, and sleep apnea, in addition to nonalcoholic fatty liver disease involving steatohepatitis (NASH) [1], which is present in ~80% of obese cases. This condition has the potential to advance to a state of severe liver fibrosis, cirrhosis, or hepatocellular cancer [2].

These effects are due to the incidence of organ fibrosis, which affects organ function and gradually damages it and may end with serious organ failure. Conservative medical therapy, involving pharmacological therapies and lifestyle adjustments focused on reducing body weight, has partially attenuated the fibrotic process associated with these disorders. The long-term reduction of excessive overweight requires discipline and perseverance, yet it is frequently unsuccessful. In the past 10 years, bariatric surgery has gained recognition as a reliable and long-lasting method for achieving significant weight loss. Roux-en-Y gastric bypass (RYGB) and sleeve gastrectomy (SG) have been found to have fewer metabolic problems in comparison to jejunoileal bypass. Therefore, these treatments are currently the most often conducted [3].

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Recent advancements in laparoscopic surgery have significantly improved the overall experience of body weight loss for individuals. These advancements have resulted in reduced pain, shorter hospital stays, fewer problems, and a speedier recovery. When performed by skilled and experienced professionals, bariatric surgeries have a safety profile that is superior to that of popular procedures such as gallbladder removal, hysterectomy, and hip replacement, with fewer risks of complications. The objective of these procedures is to alter the structure of the stomach and intestines to address obesity and its associated ailments. The surgical procedures involve reducing the size of the stomach and rerouting a section of the intestine. As a consequence, there is a reduction in the amount of food consumed and alterations in the body's ability to absorb food for energy, leading to a decrease in appetite and an increase in the feeling of fullness. These techniques enhance the body's capacity to attain a state of optimal weight [4].

Obesity is responsible for ~20–25% of renal disease cases globally. Nevertheless, the actual figure is probably far greater when accounting for intermediate disease conditions such as type 2 diabetes (the predominant global factor contributing to CKD) and hypertension (the second most prevalent cause in the United States). Diabetes and hypertension are the primary factors responsible for the majority of renal risks connected with obesity. Obesity raises the lifetime risk of CKD by 25% compared with persons with a normal weight [5].

Unfortunately, the causes of liver damage following bariatric surgery remain unidentified. Individuals with severe liver disease who have already had restriction procedures, including SG, can still benefit from them [6]. There have been no documented instances of significant liver damage following SG or gastric banding procedures. However, certain randomized trials have indicated that patients with NASH who undergo RYGB are more prone to experiencing a temporary decline in liver function in the early stages, as compared with those who undergo SG. It is hypothesized to happen as a result of distal RYGB or extended excluded limbs [7].

The objective of this work was to determine the hepatic and renal changes postbariatric surgeries, especially after SG.

2. Patients and methods

This observational prospective cohort research was performed on 100 morbidly obese patients with a BMI more than or equal to 40 kg/m^2, who underwent bariatric surgeries at Benha Teaching Hospital and DAR-ELTEB Private Hospital.

For all 100 patients, SG was the bariatric surgery of choice as we were convinced that it is the worldwide accepted surgery with a short learning curve, fewer complications, effective weight loss, and can be performed more than one time in case of regaining excess weight.

The patients' written informed consent was obtained. The Benha Teaching Hospitals Ethical Committee approved the research.

Exclusion criteria were patients with estimated glomerular filtration rate (eGFR) of less than 60%, chronic liver disease patients, and heart failure patients.

All patients were evaluated before surgery clinically and all laboratory investigations were completed before the operation as baseline, 3 months after surgery, 6 months after surgery, and after 1 year.

All patients underwent:

(1) Full history taking.
(2) Weight, height, and BMI assessment.
(3) Routine laboratory investigations:
   (a) Complete blood count.
   (b) Fasting and postprandial blood glucose and glycated hemoglobin (HbA1c).
   (c) Lipid profile [cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and triglycerides (TG)].
   (d) Liver function tests [serum bilirubin, serum glutamic oxaloacetic transaminase (SGOT), serum albumin, serum glutamic-pyruvic transaminase (SGPT)].
   (e) Renal function tests (serum creatinine, serum urea).
   (f) eGFR was calculated by CKD-EPI Creatinine Equation 2021.
   (g) 24 h urinary protein.

The SG was laparoscopically done with the patient under general anesthesia using the classic five-port technique. The dissection for laparoscopic sleeve gastrectomy (LSG) began by mobilizing the larger curve of the stomach, starting 6 cm before the pylorus and continuing to the angle of His. Particular attention was given to fully exposing the left crural pillar. Gastric resection is performed by utilizing typically five to seven vertical 60 mm staple cartridges besides a 36 Fr bougie 6 cm before the pylorus. Omentum along the greater curvature was dissected and mobilized after being dissected and cauterized by the LigaSure with good hemostasis. The free mobility of the fundus should be ascertained with proper identification of the left crus. Stapling over 36 Fr bougie usually started with first staples of green color and then later four or five blue staples were used. Proper apposition of both anterior and posterior walls of the stomach is mandatory to create a small symmetrical banana-shaped remaining stomach pouch. A leak test with methylene blue is usually done and then a size 20 Nelton drain is inserted; 10 mm ports were closed under vision using sheath closure and then the abdomen is deflated, and the camera extracted.

It was allowed for the patient to drink from day 1, and with no complications; hospital discharge was permitted between day 2 and day 3 after surgery.

2.1. Sample size calculation

We found that the prevalence of obesity was higher than 30% in the United States [8]. We calculated a sample size of 86 individuals by Epi Info calculator with a power of 80%. The confidence interval was 95%. The ratio of exposed to nonexposed was 1 : 1, and we added a 15% drop rate to be 100 patients, total sample.

2.2. Statistical analysis

The statistical analysis was conducted utilizing the SPSS, v26 software (IBM Inc., Armonk, New York, USA). The normality of the data distribution was assessed using the Shapiro−Wilks test and histograms. The quantitative parametric data were expressed as the mean and SD and were evaluated using an unpaired Student's *t* test. The qualitative data were displayed in terms of frequency and percentage (%). A two-tailed *P* value less than or equal to 0.05 was deemed to be statistically significant.

Table 1. Demographic and comorbid data of the examined cases.

	N = 100
Age (years)	38.69 ± 11.63
Sex	
Male	28 (28)
Female	72 (72)
HTN	31 (31)

Data are presented as mean ± SD or frequency (%).
HTN, hypertension.

3. Results

There were 28 (28%) males and 72 (72%) females. The age of the studied patients varied from 22 to 65 years with a mean ± SD of 38.69 ± 11.63 years. Of the patients, 31 (31%) were hypertensive (Table 1).

Weight and BMI were significantly decreased after surgery through all time measurements ($P < 0.05$, Table 2).

Hemoglobin, hematocrit, and platelets were insignificantly different at different time measurements (Table 3).

Postprandial blood glucose, fasting blood glucose, and HbA1c were significantly decreased after surgery through all time measurements ($P < 0.05$) (Table 3).

Regarding lipid profile, cholesterol, LDL, and TG were significantly decreased after surgery through all time measurements ($P < 0.05$), while HDL was significantly increased after surgery through all time measurements ($P < 0.001$) (Table 3).

Regarding liver function tests, SGOT and SGPT were significantly decreased after 3 and 6 months with no significant difference after 12 months than at 6 months. Bilirubin was significantly increased after 3 months than baseline, then it was significantly decreased after 6 months than at 3 months with no significant difference after 12 months than 6 months. Albumin was insignificantly different at different time measurements (Table 3).

Regarding kidney function tests, urea was significantly decreased after surgery through all time measurements ($P < 0.05$). Creatinine was insignificantly different after 3 months than baseline, while a significant decrease was achieved after 6 and 12 months ($P < 0.001$) (Table 3).

eGFR was insignificantly different after 3 months than baseline, while a significant increase was achieved after 6 and 12 months (Table 3).

A 24 h urinary protein was significantly decreased after surgery through all time measurements (Table 3).

4. Discussion

SG is very effective in enhancing body weight, BMI, as well as lipid profiles by modifying the

Table 2. Weight and BMI before and after surgery.

	Baseline	3 months	*P* value[a]	6 months	*P* value[b]	12 months	*P* value[c]
Weight (kg)	142.29 ± 30.05	121.71 ± 24.6	<0.001[d]	104.25 ± 20.88	<0.001[d]	95.1 ± 19.36	0.002[d]
BMI (kg/m^2)	45.46 ± 3	36.43 ± 3.3	<0.001[d]	32.98 ± 3.41	<0.001[d]	29.42 ± 3.55	<0.001[d]

[a] *P* value of 3 months compared with the baseline.
[b] *P* value of 6 months in comparison to 3 months.
[c] *P* value of 12 months in contrast to 6 months.
[d] Significant as *P* value less than or equal to 0.05.

Table 3. Laboratory investigations of examined patients.

	Baseline	3 months	*P* value[a]	6 months	*P* value[b]	12 months	*P* value[c]
Hb (g/dl)	12.14 ± 1.2	12.2 ± 1.21	0.742	12.22 ± 1.22	0.889	12.3 ± 1.21	0.638
HCT (%)	42.32 ± 4.52	43.5 ± 4.85	0.076	42.8 ± 5.23	0.328	42.41 ± 5.38	0.604
Platelets ($10^3/mm^3$)	304.96 ± 82.99	299.18 ± 83.58	0.624	296.86 ± 84.33	0.845	292.56 ± 83.94	0.718
Fasting blood glucose (mg/dl)	101.63 ± 28.61	81.71 ± 29.09	<0.001[d]	67.12 ± 28.38	<0.001[d]	54.48 ± 25.69	0.001[d]
Postprandial blood glucose (mg/dl)	142.11 ± 28.87	122.33 ± 29.22	<0.001[d]	107.32 ± 29.86	<0.001[d]	94.8 ± 26.44	0.002[d]
HbA1c (%)	6.5 ± 1.28	5.76 ± 1.3	<0.001[d]	4.52 ± 1.31	<0.001[d]	3.29 ± 1.31	<0.001[d]
Cholesterol (mg/dl)	281.82 ± 44.94	242.03 ± 44.87	<0.001[d]	207.38 ± 44.46	<0.001[d]	182.1 ± 44.65	<0.001[d]
HDL (mg/dl)	32.43 ± 7.59	38 ± 7.91	<0.001[d]	47.8 ± 7.84	<0.001[d]	55.12 ± 8.01	<0.001[d]
LDL (mg/dl)	157.18 ± 27.82	148.19 ± 27.91	0.024[d]	139.13 ± 28	0.023[d]	131.2 ± 27.87	0.046[d]
TG (mg/dl)	177.22 ± 35.09	167.17 ± 35.06	0.044[d]	153.54 ± 35.01	0.006[d]	137.35 ± 35.16	0.001[d]
SGOT (U/l)	30.47 ± 14.77	23.71 ± 13.15	0.001[d]	18 ± 11.29	0.001[d]	17.42 ± 10.98	0.713
SGPT (U/l)	39.61 ± 20.04	31.92 ± 19.66	0.007[d]	24.92 ± 17.98	0.009[d]	23.4 ± 17.8	0.549
Albumin (g/dl)	4.42 ± 0.52	4.36 ± 0.52	0.416	4.32 ± 0.54	0.577	4.31 ± 0.54	0.948
Bilirubin (mg/dl)	0.52 ± 0.25	0.77 ± 0.26	<0.001[d]	0.61 ± 0.27	<0.001[d]	0.56 ± 0.27	0.195
Urea (mg/dl)	27.03 ± 10.17	23.59 ± 8.09	0.009[d]	17.92 ± 6.3	<0.001[d]	10.51 ± 3.86	<0.001[d]
Creatinine (mg/dl)	1.01 ± 0.18	0.98 ± 0.14	0.210	0.82 ± 0.13	<0.001[d]	0.75 ± 0.12	<0.001[d]
eGFR (60 ml/min/1.73 m^2)	81.45 ± 16.26	84.07 ± 12.96	0.209	100.27 ± 12.27	<0.001[d]	109.48 ± 10.94	<0.001[d]
24 h urinary protein (mg/dl)	159.36 ± 85.58	133.13 ± 76.92	0.024[d]	98.18 ± 54.82	<0.001[d]	69.06 ± 42.5	<0.001[d]

eGFR, estimated glomerular filtration rate; HbA1c, glycated hemoglobin; HCT, hematocrit; HDL, high-density lipoprotein; LDL, low-density lipoprotein; SGOT, serum glutamic oxaloacetic transaminase; SGPT, serum glutamic-pyruvic transaminase; TG, triglycerides.
[a] P value of 3 months compared with the baseline.
[b] P value of 6 months in comparison to 3 months.
[c] P value of 12 months in contrast to 6 months.
[d] Significant as P value less than or equal to 0.05.

structure and function of the stomach to reduce food intake and suppress the release of appetite-inducing hormones. Reducing BMI enhances insulin sensitivity and lowers fasting blood sugar levels. Enhancing hyperglycemia and blood pressure control leads to improved renal function while increasing HDL levels decreases liver steatosis and enhances serum liver enzyme levels. The primary disadvantage is a decrease in hemoglobin levels caused by deficits in macronutrients and micronutrients [9].

The purpose of this work was to determine the hepatic and renal changes postbariatric surgeries, especially post-SG.

This observational prospective cohort research was carried out on 100 morbidly obese cases with a BMI equal to or more than 40 kg/m^2, who underwent bariatric surgeries at Benha Teaching Hospital and DAR-ELTEB Private Hospital.

In our trial, there were 28 (28%) males and 72 (72%) females. The age of the studied patients ranged from 22 to 65 years with a mean ± SD of 38.69 ± 11.63 years. Of these, 31 (31%) patients were hypertensive.

In accordance, Laibee *et al*. [9] reported that the study enrolled a significantly higher proportion of female individuals, as indicated by their significantly greater BMI levels in comparison to the male participants. This may be the result of the fact that many women in Middle Eastern societies are relatives who do not work and have limited access to physical activities; female body image is also significantly more stigmatized than male body image. Despite males having greater body weights, females had higher BMI levels due to their anatomically and inherently lower heights.

In our study, weight and BMI were significantly decreased after surgery through all time measurements ($P < 0.05$).

The current study is in agreement with Laibee *et al*. [9], who reported a rapid reduction in body weight and BMI after LSG.

This is in line with Bassiony *et al*. [10], who aimed to evaluate the short-term renal consequences of bariatric surgery and compare these effects between two different versions of the procedure. According to their assessment, all anthropometric parameters showed significant reductions 6 months after undergoing bariatric surgery.

Based on these findings, Kular *et al*. [11] revealed that one anastomosis gastric bypass (OAGB) and LSG both lost weight similarly in the first 2 years following bariatric surgery. Later on, nevertheless, compared with the OAGB procedure, the LSG showed a smaller percentage of weight loss. Greater weight loss was observed 1 year after OAGB surgery, according to another study [12].

In our study, hemoglobin, hematocrit, and platelets were insignificantly different at different time measurements.

This disagrees with Laibee *et al*. [9], who reported that the hemoglobin level decrease in the short term was one of the unfavorable effects of SG that their study encountered.

Anemia and other nutritional deficits are common complications of bariatric surgery. Bariatric surgery can aggravate iron deficiency, which is prevalent in severely obese patients [13]. Intraoperative hemorrhage is one possible cause of iron deficiency; however, the most common cause is relative iron deficiency due to high transferrin deficiency rates without ferritin deficiency. A vitamin B12 shortage owing to malabsorption as a result of reduced intrinsic factor secretion as a result of a decrease in the volume of intrinsic factor-producing parietal cells is another potential contributor to the onset of postgastrectomy anemia [14].

In our study, fasting blood glucose, postprandial blood glucose, and HbA1c were significantly decreased after surgery through all time measurements ($P < 0.05$). Regarding lipid profile, cholesterol, LDL, and TG were significantly decreased after surgery through all time measurements ($P < 0.05$), while HDL was significantly increased after surgery through all time measurements ($P < 0.001$).

In harmony, Laibee *et al*. [9] reported that SG significantly improves lipid profile and fasting blood sugar levels.

It has been shown that SG improves these parameters through dietary modification and by enhancing the regulatory effects of insulin on lipid, glucose, as well as amino acid metabolism [15].

In our study, regarding liver function tests, SGOT and SGPT were significantly decreased after 3 and 6 months with no significant difference after 12 months than at 6 months.

Nonalcoholic fatty liver disease and hepatic steatosis are frequently observed in individuals with morbid obesity, as indicated by increased liver enzymes (aspartate aminotransferase, alanine aminotransferase) and reduced HDL levels. There is a negative relationship between the increase in HDL levels after surgery and the evolution of liver steatosis, while there is a positive connection with normal liver enzyme levels [16].

Consistent with this research, Ruiz-Tovar *et al*. [17] showed that SG is associated with increased liver steatosis, as evaluated by ultrasonography and liver enzymes.

In our research, albumin was insignificantly different at different time measurements.

Li *et al*. [18] revealed that obese people undergoing bariatric surgery may see a significant decrease in urine albumin levels.

Proteinuria in addition to albuminuria levels declines after 12 months of undergoing RYGB, as observed in 24-hurine samples [19]. Albuminuria shows further improvement after 24 months of follow-up [20]. Bariatric surgery can enhance the urine albumin−creatinine ratio in individuals with preoperative microalbuminuria and lead to the resolution of microalbuminuria [21]. Among individuals with diabetes, the percentage of microalbuminuria remission can reach up to 60% after 5 years of monitoring. The user's text is “(22).” This is in contrast to an anticipated remission rate of 18% in groups of individuals with type 2 diabetes [22].

In cases of “normoalbuminuria,” there is no reduction in the excretion of protein during the period from 4 weeks to 6 months following bariatric surgery [23]. Nevertheless, in this group, bariatric surgery prevents the occurrence of microalbuminuria [21]. Microalbuminuria occurrences can be cut by more than 80% with bariatric surgery as contrasted with medical treatment alone [24].

In our study, regarding kidney function tests, urea was significantly decreased after surgery through all time measurements. Creatinine was insignificantly different after 3 months than baseline, while a significant decrease was achieved after 6 and 12 months. eGFR was insignificantly different after 3 months than baseline, while a significant increase was achieved after 6 and 12 months.

Holcomb *et al*. [25] studies have shown that bariatric surgery, such as gastric bypass or SG, enhances GFR through increasing blood pressure and glycemic management after the surgery. The current investigation confirms the normalization of serum creatinine levels, supporting the observed impact. The persistence of elevated blood urea levels in certain patients after surgery may not be directly linked to renal function but rather may be attributed to other variables such as insufficient fluid consumption or a diet high in protein. This underscores the importance of providing effective patient education concerning fluid and dietary intake.

Other investigations on individuals who preserved renal function revealed similar results following bariatric surgery [26,27].

A systematic review and meta-analysis by Li *et al*. [18] investigates if bariatric surgery improves GFR, proteinuria, or albuminuria. After the procedure, they noticed a significant increase in eGFR.

Several studies have demonstrated that obese patients with CKD II and III may benefit from improved GFR following bariatric surgery [28,29]. In addition, bariatric surgery has been shown to have favorable effects on the kidneys [30].

Bassiony *et al*. [10] reported that the average 24-h urinary creatinine clearance (CL_{Cr}) reduced dramatically from 224 to 145.4 ml/min/1.73 m^2. Moreover, 25 out of 54 patients who had abnormally high glomerular filtration before the surgery had a normal CL_{Cr} 6 months after the procedure. This can be attributed to the significantly elevated preoperative CL_{Cr} resulting from the very high BMI of 56.1 ± 9.64 kg/m^2, the relatively young age of the participants (36.7 ± 8.88 years), and the exclusion of individuals using medications that could potentially impact GFR, such as ACE inhibitors or ARBs. A meta-analysis found that the average GFR decreased by 25.6 ml/min/1.73 m^2 after bariatric surgery [31].

Individuals with eGFRs within the normal range at the start of the trial had modest increases of 81–99 ml/min 1 year after surgery, according to other prospective findings in a cohort of 233. Stage 3 renal disease patients were also included in this study, and their eGFR increased from 49 to 67 ml/min [32].

In our study, 24 h urinary protein was significantly decreased after surgery through all time measurements ($P < 0.05$).

Similarly, Bassiony *et al.* [10] reported that a significant decrease from 220 to 112 mg/day of median urine protein excretions was seen following bariatric surgery.

After surgery, bariatric surgery has been found to reduce proteinuria and albuminuria, according to numerous studies and meta-analyses. To what extent improved blood pressure and insulin resistance mediate this impact or if it is a direct result of weight loss is unknown [18,33].

4.1. Conclusions

Bariatric surgery, particularly SG, was effective in achieving significant weight loss and lowering BMI over the follow-up period. More than that, it improved several metabolic markers, including HDL levels, cholesterol, fasting and postprandial blood glucose, HbA1c, LDL, and TGs. Significant improvements were also observed in liver function tests 3–6 months following surgery, including SGOT and SGPT. Moreover, at 6–12 months postoperative, there was a marked improvement in renal function, as seen by lower serum creatinine levels and higher eGFR, and a significant decrease in 24-h urine protein levels. Serum albumin levels, however, showed no significant variation across all postoperative time points.

Ethical information

This work was carried out in accordance with the Declaration of Helsinki in which a The patients' written informed consent was obtained. The Benha Teaching Hospitals Ethical Committee gave approval before the research started. The purpose and nature of the study as well as the risks were be explained to the patients or their relatives. The participants first guardians agreed that he/she would have the investigational nature of the study, its inherent risks and benefits.

Confidentiality of data was assured in which Participants' information was replaced with research identification codes (ID Codes), data collection forms were be anonymous. Patients could withdraw from the study at any time and still get the full medical service with in the facility. Patients could refuse to participate and still get the standard and their right to know the research results were ensured.

Contributing authors

Naglaa F. Al-Mihy (Main author and corresponding author): Conceived and designed the analysis.

Esayed Elmokadem: Collected the data.

Atteyat A. Semeya: Wrote the paper.

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Conflict of interest

There are no conflicts of interest.

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