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Comparison of Sleeve Gastrectomy and SASI Bypass Surgery Outcomes in Patients with Obesity After Seven Months in Shiraz

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Abstract

Background: Although bariatric surgery has been introduced as a therapeutic option for patients with obesity, there is still debate on the choice of procedure.

Objectives: This study aimed to compare two types of bariatric surgeries in patients with obesity: Sleeve gastrectomy (SG) and single anastomosis sleeve ileal (SASI) bypass.

Methods: This observational prospective study compares patients with obesity who received either of the two types of bariatric surgeries at Ghadir or Shahid Faghihi hospitals in Shiraz from October 2019 to November 2020. Metabolic profiles, shear wave liver elastography (fibroscan), and cardiac evaluations (echocardiography) were performed at baseline and then seven to eleven months after the surgery.

Results: Forty-five patients with obesity who had undergone SG and SASI bypass entered this study. Fasting plasma glucose (FPG) and triglycerides (TG) decreased during the follow-up in both groups ($P = 0.032$, $P < 0.001$, respectively). The fibrosis score decreased significantly from 6.45 (4.55) before surgery to 5.40 (3.60) after surgery, and the cardiac ejection fraction increased significantly from 61.5% (12.5%) before surgery to 65.0% (8.5%) after surgery following the SASI bypass compared to the SG ($P = 0.034$, $P = 0.008$, respectively).

Conclusions: Despite the lack of difference in weight reduction, SASI bypass, compared to sleeve gastrectomy, may result in a more rapid improvement in cardiac function and liver fibrosis.

Keywords: Sleeve Gastrectomy, SASI Bypass, Obesity, Metabolic Syndrome, Liver Fibrosis

1. Background

Obesity is a growing pandemic attributed to high energy intake, low physical activity, and genetic factors. Other contributors include endocrine diseases, mental illnesses, and the consumption of certain medications. Obesity is associated with metabolic syndrome (MetS) and atherosclerosis, including insulin resistance, type 2 diabetes mellitus (T2DM), cardiac disease, hypertension (HTN), dyslipidemia, and liver disease (1).

Adipose tissue is a dynamic metabolic, biologically active endocrine tissue that secretes leptin and adiponectin (2). Low adiponectin concentrations and elevated leptin levels are associated with obesity, insulin resistance, and MetS (3-5).

In the current pandemic of obesity, the demand for its treatment is on the rise. Non-surgical treatments include dietary interventions, increasing physical activity and exercise, and other lifestyle measures, which result in sustainable weight loss in only 5 - 8% of obese individuals. The results for pharmacologic treatment of obesity are not much better, with major concerns about their side effects (6, 7). Consequently, there is a growing demand for bariatric surgeries worldwide in those who fail to respond to non-surgical treatments (8, 9). However, the acceptance rate for

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bariatric surgery among eligible patients is still low, and there are concerns about weight loss maintenance after surgery, which should exceed 10% for a sustainable improvement in quality of life (10).

Surgical procedures are divided into two general categories. The first is restrictive surgery, such as sleeve gastrectomy (SG), in which a large part of the stomach (about 85%) is removed vertically. Previous studies have shown that SG is an effective measure for weight reduction (9, 11-13). The other type of bariatric surgery is a malabsorptive procedure, which has also been shown to be effective, despite more safety concerns (12).

Single anastomosis sleeve ileal (SASI) bypass surgery is a relatively new bariatric surgery method in which sleeve gastrectomy is followed by a side-to-side gastro-ileal anastomosis (8). This surgery is considered a mixed procedure with both restrictive and malabsorptive components. Single anastomosis sleeve ileal bypass surgery is regarded as safer, with less malabsorption morbidity compared to classical bypass surgery, due to the preserved gastroduodenal pathway. Other benefits of SASI bypass surgery include the absence of prostheses or excluded segments, easy feasibility, and the ability to perform upper endoscopic procedures, including endoscopic retrograde cholangiopancreatography (ERCP), after surgery (6).

There are some concerns about increased bile reflux with this procedure, but there is limited comparative data on the occurrence of this complication and its clinical significance in patients who have undergone the SASI operation. Whether this procedure could result in better outcomes for patients with obesity is a matter of ongoing debate.

2. Objectives

This study was designed to compare the short-term outcomes of the SG and SASI bypass procedures.

3. Patients and Methods

Patients with morbid obesity [body mass index (BMI) > 40] were referred for bariatric surgery to two referral centers in Shiraz (Ghadir or Shahid Faghihi hospitals) affiliated with Shiraz University of Medical Sciences (Shiraz, Iran) from October 2019 to November 2020. The patients underwent either SG or SASI bypass based on their preferences after discussions with a multidisciplinary team that informed them of the known pros and cons of each operation. Both groups received standard care from the same multidisciplinary team, including a surgeon, dietitian, psychiatrist, and internist, coordinated by a trained nurse.

The inclusion criteria were patients with a BMI > 40 who came to our center for obesity treatment and were deemed candidates for surgery by a commission consisting of a surgeon, nutritionist, and psychologist, after obtaining informed consent from patients aged 18 to 60 years old. The exclusion criteria included patients with a BMI > 55, a history of severe liver diseases such as hepatitis, a history of liver surgeries, heart disorders such as heart failure, arrhythmias, myocardial infarction, or stroke, and those with a history of previous laparoscopic surgery in the abdomen.

Sixty-five patients willingly entered the study, but 20 patients withdrew during the follow-up due to adherence to restrictive protocols related to the coronavirus disease 2019 (COVID-19) pandemic. Therefore, 45 patients completed the study. These 45 patients were categorized into two groups: 12 in the SASI bypass group and 33 in the SG group. Convenience sampling was used, and the sample size was calculated using MedCalc software, considering a two-to-one ratio for the groups. The formula for determining the sample size for comparing two means is given below (14). Using this formula, and considering a type 1 error of 5% and a power of 80%, the mean and standard deviation were 95.7 ± 5.8 and 89 ± 7.1, respectively. Volume formula:

$$n_1 = \frac{\left(z_{\frac{\alpha}{2}-1} + z_{\beta-1}\right)^2 \left(\frac{1}{r} \times \left(\sigma_1^2 + \sigma_2^2\right)\right) \left(\frac{\frac{1}{r}+1}{r}\right)}{\Delta^2}$$

$$n_2 = r \times n_1$$

n_1 and n_2 are the sample size in each group; r = ratio of sample size ($r = n_1/n_2$); α and β are type 1 error and the power respectively; σ_1 and σ_2 are the standard deviation of each group; Δ is the difference of the group means.

Informed consent was obtained from all the patients. The method of SASI bypass surgery is described in a previous study (6), where the first one-third of the length of the intestine from the first ligament was anastomosed to the stomach. All procedures were performed by a single surgeon, using the same operation room materials and technicians. Data were gathered before and seven to eleven months after the surgery. The weight and BMI of the patients were measured before and seven months after surgery. The patients were followed clinically by the multidisciplinary team. Typically, 50% of bariatric surgeries at our center are sleeve gastrectomies, 25% are SASI bypasses, and 25% are classic bypass surgeries. Weight loss was assessed by the difference between preoperative and postoperative weights. Postoperative complications were not reported in this study.

3.1. Biochemical Measurements

Blood samples were collected after overnight fasting (10 - 14 h). All serum samples, collected before and seven to eleven months after surgery, were prepared in a single laboratory using standard methods and stored at -70°C until analysis. Fasting plasma glucose (FPG) was measured using the glucose oxidase method. Plasma lipid profile and liver enzyme levels [alanine aminotransferase (ALT) and aspartate aminotransferase (AST)] were measured using enzymatic methods. Serum leptin, ghrelin, adiponectin, thyroid hormones, and insulin were measured using enzyme-linked immunosorbent assay (ELISA). To monitor the accuracy and precision of biochemical tests, we performed a quality control assay. HbA1C was measured using the electrophoresis method. Uric acid, total and direct bilirubin, albumin, alkaline phosphatase, calcium, and phosphorus were measured using standard biochemical methods.

3.2. FibroScan® and Echocardiography Studies

After at least four hours of fasting and avoiding physical activity, all patients were evaluated for the stage of fibrosis and fat content of the liver by a single operator using FibroScan® (ECHOSENS, 502, France). The grade of fibrosis was reported according to the manufacturer's instructions, ranging from F0 to F4. The controlled attenuation parameter (CAP) score, indicative of fatty changes in the liver, was also reported from S0 to S3 as a measure of liver steatosis.

All patients underwent a complete echocardiographic study using the EE Vivid-G Echo machine (Siemens, Germany). The anteroposterior diameter and biplane volume of the left atrium (LA) were measured in all patients. Left ventricular end-systolic diameter (LV ESD) and left ventricular end-diastolic diameter (LV EDD) were calculated in the parasternal long-axis view. As defined by the guidelines of the American Society of Echocardiography (ASE), the bipolar left ventricle ejection fraction (LVEF) was calculated using the Simpson method, and the diastolic function of the right ventricle (RV) was measured using pulse wave Doppler of the mitral valve (MV) flow and tissue Doppler study of the MV annulus.

All cardiac valves were evaluated in the transthoracic echocardiography (TTE) exam, and moderate to severe valvular stenosis or regurgitation was considered significant valvular heart disease. Systolic pulmonary artery pressure (SPAP) or mean pulmonary artery pressure (mean PAP) was measured by tricuspid regurgitation (TR) gradient or pulmonary acceleration time, respectively. The apical four-chamber view was used to evaluate the sizes of the right atrium (RA) and RV, as well as RV systolic function.

3.3. Statistical Analysis

Data were analyzed using the statistical package for social sciences (SPSS) for Windows, version 22 (Chicago, IL, USA). Data were expressed as median (IQR). The Mann-Whitney test and Wilcoxon test were used to compare each parameter of the groups before and after the surgery or between surgeries.

3.4. Ethical Considerations

The study protocol was approved by the Ethics Committee of Shiraz University of Medical Sciences (IR.SUMS.MED.REC.1399.555).

4. Results

4.1. Characteristics of the Patients

The patients' ages ranged from 18 to 57 years, with a median (IQR) of 37.0 (14.0) years, which was not significantly different between the two groups (P = 0.877, Table 1). In our study, the weight and BMI of the patients significantly decreased in both groups seven months after surgery. The median weight was 117.5 (30.5) kg before surgery and decreased to 85.0 (24.7) kg after surgery (P < 0.001). Specifically, the median weight for the SG group was 112.8 (24.5) kg before surgery and decreased to 85.0 (27.5) kg after surgery (P < 0.001). For the SASI bypass group, the median weight was 135.0 (38.5) kg before surgery and decreased to 91.5 (16.0) kg after surgery (P = 0.002). However, the decrease was not significantly different between the two types of surgery (P = 0.227, Table 1).

Table 1. Demographic Characteristics of Patients in the Two Groups Before and After 7 Months [a]

Parameters	Sleeve Gastrectomy (n=33)	SASI Bypass (n = 12)	P-Value [b]	Values
Age (y)	37.0 (14.5)	37.0 (9.5)	0.877	37.0 (14.0)
Sex				
Male	12 (36.4%)	4 (33.3%)	0.571	16 (35.6%)
Female	21 (63.6%)	8 (66.7%)		29 (64.4%)
Weight before surgery (kg)	112.8 (24.5)	135.0 (38.5)	0.010	117.5 (30.5)

Parameters	Sleeve Gastrectomy (n = 33)	SASI Bypass (n = 12)	P-Value [b]	Values
(kg)	36.0 (18.0)	42.5 (25.2)	0.227	36.0 (19.0)
% loss in body weight	32.1% (14.8)	29.9% (13.4)	0.843	29.9% (14.7)
BMI decrease	13.6 (7.0)	15.1 (7.5)	0.238	13.7 (6.5)

Abbreviations: BMI, body mass index; SASI, single anastomosis sleeve ileal.

[a] Values are expressed as median (IQR) or No. (%) unless otherwise indicated.

[b] Mann-Whitney test and chi-square test.

The percent change in BMI was a 29.8% decrease after the surgeries ($P < 0.001$). A 29.44% decrease was seen after SG, and a 30.79% decrease was observed after SASI bypass. Both SG and SASI bypass procedures significantly decreased the BMI, but the decrease was not significantly different between the two types of surgery ($P = 0.238$, Table 1).

4.2. Biochemical Measurements

The two groups were not similar at baseline, but the differences were not statistically significant (Table 2 $P > 0.05$). The mean high-density lipoprotein-cholesterol (HDL-C) level (mg/dL) increased significantly after SG ($P < 0.001$), but the rise was not significant after SASI bypass. low-density lipoprotein (LDL) levels decreased following SASI bypass but increased after SG (Table 2). Liver enzymes (AST, ALT, ALKP) and creatinine significantly decreased after SG ($P = 0.005$), but did not decrease after SASI bypass. The albumin level increased significantly after SG ($P = 0.010$) but did not change after SASI bypass. The decrease in BMI was inversely correlated with ALT and leptin levels after SG ($r = -0.371$, $P = 0.040$; $r = -0.383$, $P = 0.031$, respectively), but this correlation was not seen following SASI bypass.

Table 2. Laboratory Data of the Patients in the Two Groups

Parameters and Time	Sleeve Gastrectomy (n = 33) [a]	P-Value [b]	SASI Bypass (n = 12) [a]	P-Value [b]	P-Value [c]
Cholesterol (mg/dL)		0.009		0.347	
Before surgery	180.0 (31.0)		168.0 (44.2)		0.323
After surgery	192.0 (63.0)		179.5 (52.0)		0.228
LDL-C (mg/dL)		0.159		0.583	
Before surgery	117.0 (20.0)		104.5 (26.8)		0.329
After surgery	117.0 (28.0)		108.0 (65.8)		0.255
HDL-C (mg/dL)		< 0.001		0.136	
Before surgery	47.0 (13.0)		47.0 (13.5)		0.924
After surgery	62.0 (16.0)		59.0 (20.5)		0.233
Triglyceride (mg/dL)		0.001		0.038	
Before surgery	157.0 (83.0)		142.5 (76.0)		0.588
After surgery	112.0 (64.0)		93.0 (26.7)		0.184
FPG (mg/dL)		0.130		0.055	
Before surgery	100.0 (27.0)		108.0 (26.7)		0.174
After surgery	98.0 (13.0)		99.5 (15.5)		0.797
HbA1C (%)		< 0.001		0.003	
Before surgery	5.8 (0.5)		5.7 (1.1)		0.682
After surgery	4.9 (0.8)		5.0 (0.7)		0.422
Insulin (mlU/L)		0.022		0.859	
Before surgery	4.7 (6.0)		7.8 (6.4)		0.073
After surgery	6.5 (11.6)		6.3 (13.1)		0.713
HOMA-IR		0.017		0.477	
Before surgery	1.1 (1.4)		2.4 (1.9)		0.022
After surgery	1.6 (2.9)		1.5 (3.1)		0.746
Uric acid (mg/dL)		0.004		0.022	
Before surgery	5.5 (1.9)		6.8 (1.8)		0.137
After surgery	4.8 (1.3)		5.3 (0.5)		0.147
Total bilirubin (mg/dL)		< 0.001		0.005	
Before surgery	0.6 (0.4)		0.5 (0.5)		0.664
After surgery	0.8 (0.4)		0.7 (0.5)		0.542
Direct bilirubin (mg/dL)		< 0.001		0.003	
Before surgery	0.1 (0.1)		0.1 (0.1)		0.818
After surgery	0.3 (0.2)		0.3 (0.2)		0.946
Albumin (g/dL)		0.001		1.000	
Before surgery	4.2 (0.4)		4.3 (0.3)		0.661
After surgery	4.5 (0.5)		4.2 (0.5)		0.047
AST (U/L)		0.001		0.388	
Before surgery	30.5 (11.7)		33.5 (14. 5)		0.303
After surgery	24.0 (9.0)		31.5 (12.2)		0.004
ALT (U/L)		0.001		0.248	
Before surgery	33.5 (22.5)		37.5 (26.2)		0.562
After surgery	20.0 (16.0)		32.5 (19.2)		0.027
ALP (U/L)		0.001		0.209	

Parameters and Time	Sleeve Gastrectomy (n=33) [a]	P-Value [b]	SASI Bypass (n = 12) [a]	P-Value [b]	P-Value [c]
After surgery	150.5 (56.0)		158.5 (38.7)		0.358
Ca (mg/dL)		0.845		0.592	
Before surgery	9.5 (0.8)		9.6 (0.7)		0.616
After surgery	9.5 (0.5)		9.5 (0.9)		0.812
Phosphorus (mg/dL)		0.673		0.049	
Before surgery	3.6 (0.6)		3.2 (1.1)		0.083
After surgery	3.5 (1.0)		3.8 (0.7)		0.460
WBC (× 10 ^{9}/L)		< 0.001		0.002	
Before surgery	8.3 (3.7)		8.2 (3.1)		0.772
After surgery	6.6 (2.1)		6.2 (2.6)		0.588
Hemoglobin (g/dL)		0.341		0.724	
Before surgery	13.9 (2.1)		13. 5 (1.8)		0.493
After surgery	14.1 (2.7)		14.0 (1.3)		0.882
MCV (fL)		< 0.001		0.019	
Before surgery	81.9 (6.7)		80.9 (8.6)		0.885
After surgery	84.6 (7.0)		85.9 (5.1)		0.498
Platelet (× 10 ^{9}/L)		0.001		0.045	
Before surgery	263.5 (101.0)		275.5 (93.7)		0.895
After surgery	250.0 (86.0)		239.0 (112.5)		0.735

Abbreviations: SASI, single anastomosis sleeve ileal; BMI, body mass index; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; FPG, fasting plasma glucose; AST, aspartate aminotransferase; ALT, alanine aminotransferase; ALP, alkaline phosphatase; Ca, calcium; WBC, white blood cells; MCV, mean corpuscular volume; HOMA-IR, homeostasis model assessment-estimated insulin resistance.

[a] Values are expressed as median (IQR).

[b] Wilcoxon test was used to assess significant changes within each group following surgery.

[c] Mann-Whitney test was used to assess significant differences between the two surgery groups.

Ghrelin and leptin levels decreased significantly after both types of surgeries, but there were no significant differences between the two groups (P = 0.571, P = 0.414, respectively). Adiponectin levels increased substantially after both surgeries, but the difference was not significant between them (P = 0.598, Table 3). HbA1C decreased significantly after both types of surgery, but the decrease was similar between the groups (P = 0.422, Table 1). The drop in FPG level following both SASI bypass and SG was not significant (P = 0.055 and P = 0.130, respectively). Insulin levels and homeostasis model assessment-estimated insulin resistance (HOMA-IR) decreased after SASI bypass, but this did not reach statistical significance (P = 0.859 and P = 0.477, respectively). However, these parameters increased significantly after SG (P = 0.022 and P = 0.017, respectively).

Table 3. Hormone Levels Before and Seven Months After the Surgeries

Parameters and Time	Groups: Sleeve Gastrectomy (n = 33) Median (IQR)	Sleeve Gastrectomy P-Value [b]	SASI (n = 12) Mean ± SD	SASI P-Value [b]	P-Value [a]
Adiponectin (μg/mL)		< 0.001		0.004	
Before surgery	3.36 (3.11)		3.33 ± 2.82		0.885
After surgery	5.23 (4.04)		5.74 ± 3.41		0.598
Leptin (ng/mL)		< 0.001		0.003	
Before surgery	43.62 (51.18)		74.07 ± 62.06		0.082
After surgery	18.90 (27.15)		28.66 ± 24.00		0.414
Ghrelin (μg/mL)		0.010		0.099	
Before surgery	0.91 (0.45)		0.88 ± 0.30		0.885
After surgery	0.55 (0.55)		0.75 ± 0.62		0.571
TSH (mlU/L)		0.232		0.814	
Before surgery	2.59 (2.06)		2.86 ± 5.97		0.947
After surgery	2.40 (1.64)		2.50 ± 2.52		0.828
T3 (ng/dL)		0.020		0.168	
Before surgery	148.00 (30.50)		140.00 ± 16.00		0.686
After surgery	121.50 (33.25)		110.5 ± 122.53		0.478
T4 (μg/dL)		0.977		0.508	
Before surgery	8.57 (1.64)		7.96 ± 3.80		0.487
After surgery	8.70 (2.10)		7.50 ± 3.10		0.229

Abbreviations: SASI, single anastomosis sleeve ileal; TSH, thyroid stimulating hormone.

[a] Mann-Whitney test was used to assess significant differences between the two surgery groups.

[b] Wilcoxon test was used to assess significant changes within each group following surgery.

The blood urea nitrogen (BUN) concentration did not change significantly in either group. Uric acid decreased substantially in both groups, but the decrease was not significantly different between the groups (P = 0.147). Although total bilirubin and direct bilirubin levels increased after both types of surgeries, these changes remained within normal limits. Electrolytes and thyroid hormones also changed within normal ranges after the surgeries (Tables 2 , 3).

4.3. FibroScan® and Echocardiography Studies

The CAP score decreased significantly after both types of surgeries, with no significant difference between the groups (P = 0.772) (Table 4). The fibrosis score decreased significantly only after SASI bypass (P = 0.034) (Table 4). Tables 5 and 6 show the fibroscan grades and steatosis stages in the two groups before and after the surgeries.

Table 4. FibroScan® and Echocardiographic Parameters Before and Seven Months After the Surgeries

Parameters and Time	Groups				P-Value [a]
	Sleeve Gastrectomy (n = 33)		SASI (n = 12)		
	Mean ± SD	P-Value [b]	Mean ± SD	P-Value [b]	
EF (%)		0.620		0.008	
Before surgery	63.0% ± 10.7%		59.0% ± 12.0%		0.047
After surgery	64.0% ± 7.0%		66.0% ± 8.5%		0.415
LA volume (mL/m²)		0.808		0.109	
Before surgery	45.0 ± 17.0		43.0 ± 14.0		0.568
After surgery	48.0 ± 13.0		45.0 ± 26.5		0.767
LVEDD (cm)		0.224		0.345	
Before surgery	4.6 ± 0.9		4.9 ± 1.1		0.231
After surgery	4.7 ± 0.6		5.2 ± 0.7		0.142
Fibroscan score (kPa)		0.131		0.034	
Before surgery	6.1 ± 5.1		6.9 ± 4.2		0.176
After surgery	5.5 ± 4.4		5.5 ± 4.0		0.445
CAP score (dB/m)		< 0.001		0.041	
Before surgery	329.0 ± 75.0		318.5 ± 129.5		0.839
After surgery	249.5 ± 113.2		251.0 ± 76.7		0.772
Steatosios (%)		< 0.001		0.327	
Before surgery	79.0% ± 23.0%		69.0% ± 63.5%		0.083
After surgery	31.0% ± 72.0%		29.0% ± 56.0%		0.689

Abbreviations: SASI, single anastomosis sleeve ileal; EF, ejection fraction; LA, left atrium; LVEDD, left ventricular end-diastolic diameter; CAP, controlled attenuation parameter.

[a] Mann-Whitney test was used to assess significant differences between the two surgery groups.

[b] Wilcoxon test was used to assess significant changes within each group following surgery.

Table 5. FibroScan® Grades in the Two Groups Before and After the Surgeries

Operation Type	Fibroscan Grade, Frequency (%)			P-Value [a]
	F0 - F1	F2 - F3	F4	
Sleeve gastrectomy				0.161
Before surgery	19 (57.6)	12 (36.4)	2 (6)	
After surgery	24 (72.8)	8 (24.2)	1 (3)	
SASI bypass surgery				0.095
Before surgery	6 (50)	6 (50)	0	
After surgery	9 (75)	3 (25)	0	

Abbreviation: SASI, single anastomosis sleeve ileal.

[a] Pearson chi-square test.

Table 6. Steatosis Stages in the Two Groups Before and After the Surgeries

Operation Type	Steatosis Stage, Frequency (%)				P-Value [a]
	S0	S1	S2	S3	
Sleeve gastrectomy					0.132
Before surgery	3 (9.1)	1 (3)	6 (18.2)	23 (69.7)	
After surgery	14 (42.5)	5 (15.1)	4 (12.1)	10 (30.3)	
SASI bypass surgery					0.518
Before surgery	2 (16.7)	0	2 (16.7)	8 (66.6)	
After surgery	3 (25)	5 (41.7)	1 (8.3)	3 (25)	

Abbreviation: SASI, single anastomosis sleeve ileal.

[a] Pearson chi-square test.

4.4. Echocardiography Study

The LV diastolic function, RV function, RV size, RA size, and pulmonary artery pressure were within the normal range in all patients before and after the surgeries. There was no significant valvular heart disease or pulmonary hypertension before or after the surgeries.

Before the surgery, two patients in the sleeve group had grade 1 heart failure, and three in the SASI bypass group had stage 1 heart failure. However, after the surgery, all patients showed improvement with ejection fraction (EF) > 55%. The EF percentage increased significantly after SASI bypass (P = 0.008) but not after SG (P = 0.620), and the difference between the two groups was significant (P = 0.045, Table 4). The decrease in BMI after SG correlated with the rise in EF (r = 0.416, P = 0.031), indicating that a greater decline in BMI led to a larger increase in EF percentage.

Before and after the surgery, the LA volume in all patients was normal (i.e., less than 34 mL per square meter) and decreased non-significantly after both surgeries (SASI bypass: P = 0.109, SG: P = 0.808). The LV EDD in the two groups before and after the surgeries was within normal ranges for all patients.

5. Discussion

The rational goal of bariatric surgeries should not only be to decrease weight but also to ensure the patient's quality of life and wellbeing, including the improvement of vital organ function and alleviating the adverse effects of obesity on the heart, liver, kidneys, and other organs. In this study, BMI decreased significantly with both SG and SASI bypass operations, with a trend toward more weight reduction with the latter. These results are similar to the study by Emile et al., which showed that the percentage of excess weight loss (EWL%) at six months postoperatively was similar between the two groups (15).

In this study, it was shown that insulin levels and HOMA-IR decreased after SASI bypass and increased after SG. This is also in line with Emile et al.'s study results, which showed that the improvement in T2DM after SASI bypass was better compared to SG (15). Our results indicated that HbA1C, a long-term predictor of glucose control, decreased significantly and to a similar degree in both groups, as did the TG level. Emile et al. also reported a better improvement in the metabolic profile in the long term after SASI bypass. They indicated that the EWL% reached 90% at one year and the remission rates of hypertension, hypercholesterolemia, and hypertriglyceridemia were 86%, 100%, and 97%, respectively (15). In another study, Salama et al. showed significant decreases in the plasma levels of FPG, insulin, and LDL and a significant increase in HDL plasma levels following SASI bypass (8).

In this study, adiponectin levels increased significantly, and leptin and ghrelin concentrations decreased considerably after both surgeries ($P < 0.001$ for both). Similar results were reported by Buzga et al. (4). Ghrelin and leptin levels decreased significantly after both types of surgeries, but there were no significant differences between the two groups ($P = 0.571$, $P = 0.414$). Adiponectin levels increased substantially after both surgeries, but the difference was not significant between them ($P = 0.598$, Table 3).

In our study, after SG, the creatinine level significantly decreased ($P = 0.005$). The mean concentrations of liver enzymes decreased but were within the normal range in both groups before and after surgeries, although the decrease was more prominent following SG ($P < 0.05$). The reduction in BMI after SG was inversely correlated with ALT and leptin levels.

The CAP score, an indicator of fatty changes in the liver, decreased significantly after both types of surgeries, with no significant difference between the groups ($P = 0.772$) (Tables 4 , 6). The liver fibrosis score decreased significantly only after SASI bypass surgery ($P = 0.034$).

The EF% increased significantly after SASI bypass surgery ($P = 0.008$). The contraction power of the heart also improved due to weight loss, which is a sign of metabolic syndrome improvement.

This study, with a short-term follow-up, revealed comparable efficacy of SG and SASI bypass surgeries in weight loss and several metabolic indicators while showing more rapid improvement of liver fibrosis and cardiac function with SASI bypass. The significance of this advantage of SASI bypass needs to be demonstrated in long-term studies.

5.1. Limitations

This study reports on a small series from a single center, comparing heterogeneous groups (12 SASI vs. 33 SG). There was no matching and no randomization in our groups because the patients chose the type of surgery. The generalization of our findings needs to be confirmed in larger multicenter studies.

5.2. Conclusions

In conclusion, our data revealed that both SASI bypass and SG are effective and safe in the treatment of morbid obesity. The more rapid improvement of cardiac function and liver fibrosis observed with SASI bypass could be an advantage in certain circumstances. However, this finding needs to be confirmed in larger, randomized long-term studies.

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Footnotes

Authors' Contribution: SVH contributed to the conception of the work, conducted the study, revised the draft, approved the final version of the manuscript, and agreed with all aspects of the work. SAH and AM contributed to the conception of the work, drafted and revised the draft, approved the final version of the manuscript, and agreed with all aspects of the work. HKh contributed to the conception of the work, conducted the study, revised the draft, approved the final version of the manuscript, and agreed with all aspects of the work. KBL contributed to the conception of the work, revised the draft, approved the final version of the manuscript, and agreed with all aspects of the work.

Conflict of Interests Statement: There is no conflict of interests.

Data Availability: The datasets generated and analyzed during the current study are not publicly available due to the ethics protocol, but they are available from the corresponding author upon reasonable request.

Ethical Approval: All methods of the study protocol were carried out in accordance with the Ethics Committee of Shiraz University of Medical Sciences in accordance with the Declaration of Helsinki (IR.SUMS.MED.REC.1399.555).

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