Original Article

Sleeve Gastrectomy Versus Single Anastomosis Sleeve Ileal Bypass in The Management of Type II Diabetic Patients with Morbid Obesity

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ABSTRACT

Background: Both laparoscopic sleeve gastrectomy (LSG) and single anastomosis sleeve ileal bypass (SASI) have become popular bariatric procedures in Egypt. However, their effect on obese diabetic patients is understudied. In the current study, we compared the previous two metabolic procedures regarding weight loss and improvement of comorbidities in obese patients with type 2 diabetes mellitus.

Patients and Methods: We enrolled 32 diabetic patients whose BMI was more than 35kg/m^2 in this prospective randomized trial. They were allocated into two groups (16 cases in each): LSG and SASI groups.

Results: All preoperative parameters were comparable between the study groups. Nonetheless, the duration of operation increased significantly in the SASI group. The excess weight loss percentage showed a significant increase with time, and it was comparable between the two procedures. Fasting, postprandial plasma glucose, and glycated hemoglobin showed a significant decline in both study groups compared to the baseline, and these follow-up readings were comparable between the two procedures, indicating comparable diabetic outcomes between the two procedures. A positive impact on diabetes (improvement or remission) was noticed in 87.5 and 93.75% of cases in the two groups, respectively, with no statistically significant difference. The improvement of hypertension and dyslipidemia also did not differ between the two groups. No significant nutritional deficiencies were encountered in either group. However, reflux outcomes were better in association with the SASI procedure.

Conclusion: Both LSG and SASI procedures have comparable short-term outcomes regarding weight loss and improvement of the diabetic state, along with other obesity-related comorbidities.

Key Words: Single anastomosis sleeve ileal bypass; Sleeve gastrectomy; Type 2 diabetes.

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INTRODUCTION

Obesity and type 2 diabetes mellitus (T2DM) are significant concerns for Egyptian health authorities due to their high prevalence in the population[1]. The former had a prevalence of 39.8% according to the recent “100 million health survey”[2], while the latter is estimated to affect at least 13.6% of the adult Egyptian population[3,4]. A robust documented correlation exists between obesity and T2DM, with ~80% of diabetic individuals being obese[5,6].

Medical treatment is the primary management strategy for patients with type 2 diabetes. However, it frequently produces disappointing results in diabetes patients with obesity[7]. Currently, bariatric or metabolic surgery has been demonstrated to be more helpful in managing such individuals[8,9]. It has been claimed that hormonal changes following these surgeries help to alleviate or resolve the current diabetic state that occurs even before significant weight loss[10].

Laparoscopic sleeve gastrectomy (LSG) is now extremely popular among Egyptian bariatric surgeons due to its technical simplicity and outstanding weight loss results[11–14], and comparable reduction of obesity-related comorbidities with more complex malabsorptive surgeries such as Roux-en-Y gastric bypass[15,16].

A new metabolic approach, single anastomosis sleeve ileal bypass (SASI) surgery, was recently introduced to

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the Egyptian surgical community. The concept is based on the Santoro operation and the minigastric bypass procedure. LSG is performed first, followed by a side-to-side anastomosis between the distal small bowel and the stomach antrum[17]. Several studies have shown excellent results in terms of weight loss and comorbidity improvement[17–19].

Studies comparing LSG and SASI procedures are conspicuously lacking, particularly when it comes to individuals with type 2 diabetes. In order to compare the two metabolic treatments that were previously performed in terms of weight loss metrics and comorbidity improvement in obese patients with DM, we carried out the current study.

PATIENTS AND METHODS:

The Institutional Review Board (IRB) of our medical school granted ethical approval for this prospective randomized study, which was carried out at the Surgery Department and Endocrine Surgery Unit at Mansoura University Hospitals (no. 18.7.65). Adults with type 2 diabetes who were scheduled for bariatric surgery between July 2018 and July 2020 and had a BMI of greater than 35kg/m^2 were included in the research. All patients gave their written informed consent after being fully told about the study's objectives, the anticipated results, and any potential risks associated with each surgery.

Power analysis was performed to determine the required sample size. A power of 80% was estimated with a type 1 error of 0.05 and an enrollment ratio of one to achieve a difference in fasting plasma glucose (FBG) between groups of roughly 10mg/dl, resulting in a total sample size of 32 cases (16 cases per group).

The inclusion criteria were: (a) age range of 18–60 years, (b) signed informed consent, (c) patients with BMI more than or equal to 35kg/m^2 with T2DM, and (d) patients who are fit for general anesthesia and surgery without any contraindications.

The exclusion criteria were: (a) age less than 18 and more than 60 years, (b) patients who are unfit for general anesthesia or operation, (c) active gastric or duodenal ulcer, (d) active inflammatory bowel disease, and (e) patients with active psychological disease (e.g. psychosis, uncontrolled depression, active substance abuse).

The included participants received the standard preoperative evaluation, including history taking (especially the duration and treatment of T2DM and other obesity-related comorbidities), clinical examination, routine laboratory investigations and plasma glucose (fasting, postprandial, and random), glycosylated hemoglobin (HbA1c) and lipid profile. In addition, all patients underwent pelviabdominal ultrasonography. Upper gastrointestinal endoscopy and pulmonary function tests were performed for evaluation when needed in some patients. Patients were admitted to the ward the night before surgery, where they received prophylactic anticoagulation (low molecular weight heparin) 12h before surgery.

The participants were randomly allocated into two groups via the "sealed envelope method"; group I underwent LSG and group II underwent SASI bypass.

In both groups, the operations were performed via laparoscopy, and standard protocol was followed[14] under general anesthesia in the supine position and splitting of the operating table into legs. A broad-spectrum antibiotic was administered at the time of the skin incision. Abdominal insufflation was done via the Veress needle in Palmer's point at 15mmHg. The port design was similar in both groups as the following; one supraumbilical port for the camera 2–3cm to the left of midline about 20cm from xiphoid process, the rest of ports were inserted under direct vision as the following manner: two 12mm working ports at the left and right midclavicular lines, one 5mm assisting port at the left anterior axillary line, and another 5mm assisting epigastric port for liver retraction. The operative table position was changed to steep reverse Trendelenburg's position.

In the LSG, we started gastric devascularization 2–6cm from the pylorus using a harmonic device (Ethicon Endosurgery USA), and the devascularization was continued cranially till reaching the angle of His and identifying the left diaphragmatic crus[13]. After inserting a 38Fr bougie, gastric transection was performed via the surgical endostapler (Ethicon Endosurgery USA or Covedien Medtronic, USA), starting with a green cartridge, the second cartridge was gold (in Ethicon Endosurgery USA staplers only), then the rest of the cartridges were blue stapling was completed in the direction of the gastro-esophageal junction. Clipping was used to stop any bleeding sites along the staple line.

The identical LSG procedures were followed in the SASI group, with the exception that we began the devascularization process 6 cm away from the pylorus to allow enough space for the gastroileal anastomosis[17]. Following the LSG, an anastomosis was performed between the antrum and the ileum, with a width of 2–3cm and a distance of around 2.5m from the ileocecal valve[17]. Vicarly sutures (2/0) were used continuously to seal the remaining defect.

Following adequate hemostasis, an intra-abdominal drain was placed in all patients. The transacted specimen was retrieved via the 12mm right midclavicular port, and an intraoperative methylene blue test was performed in both study groups to rule out leakage.

The vast majority of patients were transferred to the ward; a few were admitted to the ICU for the first 24h before being moved to the ward. In order to identify complications early, all patients had their general symptoms, such as fever, tachycardia, dyspnea, and tachypnea, and clinical symptoms such as cough, left shoulder discomfort, stomach pain, abdominal distension, and peritonism were tracked. On the first postoperative day, all patients underwent a standard water contrast test. If there was no radiological or clinical indication of gastric leakage, a clear fluid diet was implemented. Depending on the patient's health and the surgeon's desire, the drain was removed between the third and fifth postoperative days. When there is one or more of the following criteria: (a) tachycardia, (b) hypotension, (c) new blood in the drain bag, and (d) a hemoglobin decline in the complete blood count, bleeding was suspected. Postoperative leakage was suspected when there was one or more of the following: (a) fever, (b) tachycardia, (c) tachypnea, (d) stomach discomfort, or (e) abdominal distention, (f) pain in the left shoulder. In such patients, oral contrast computed tomography was used to rule out surgical leakage. Extravasation of contrast agent through the gastric sleeve wall, buildup next to the sleeve, free intra-abdominal fluid, and free intra-abdominal gas were among the findings that were indicative of gastric leakage. With the exception of cases of morbidity, patients were released[14,20,21].

Following the removal of the stitches, all patients were scheduled for follow-up appointments at 3, 6, 9, and 12 months following the procedure. Patients were advised to report any symptom development at these intervals.

To assess the impact of both groups of surgeries on the patients' diabetes status, we used the criteria reported by Brethauer *et al*.,[22] as the main outcome measure.

Bariatric surgery glycemic outcomes and definition of each are the following:

1. Complete remission: normal glucose parameters (HbA1c<6%, FBG<100 mg/dl) without use of diabetic medications.

2. Partial remission: hyperglycemia below diabetic level (HbA1c 6–6.4%, FBG 100–125mg/dl) without use of diabetic medications.

3. Improvement: HbA1c level reduction by a statistically significant value with FBG not reaching criteria of remission or decreased usage of diabetic medications (stopping insulin or one oral antidiabetic drug or reduction of dose by half).

4. Unchanged: no remission (partial or complete) or improvement as described above.

Recurrence

Diabetic level FBG or HbA1c (≥126mg/dl and ≥6.5%, respectively) or diabetic medication are needed again after a period of remission (complete or partial)[42].

The secondary outcome measures included (a) evaluating the development of complications, as defined by Brethauer *et al.,*[22] published definitions of reflux (bleeding, leakage, and reflux), (b) evaluating de novo reflux, which was defined as the occurrence of postoperative reflux symptoms in patients who did not have reflux before surgery[23]. (c) The excess weight loss percentage (%EWL). (d) Nutritional deficiency, such as alterations in hemoglobin and albumin, serum ferritin, and serum calcium. (e) Dyslipidaemia improvement. (f) Reduction of blood pressure in patients with a history of hypertension.

We tabulated and analyzed the data using SPSS software. Numerical data were presented using either the median with range or the mean with SD. While the paired *t* test was used to compare data within the same group at different times, the Student t test was used to compare data between the two groups. The χ^2 or Fisher's exact tests were used to compare the two groups' categorical data, which were represented as numbers and percentages. For any of the aforementioned tests, a *P* value of less than 0.05 was considered statistically significant.

RESULTS:

The study flow chart is shown in Figure (1).

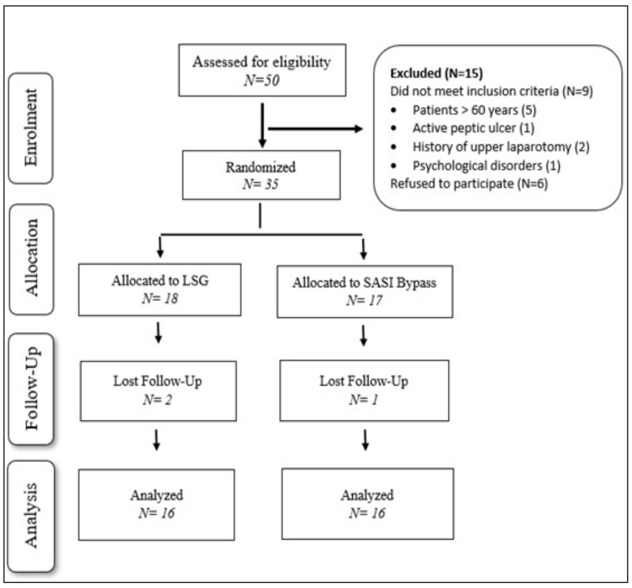

Figure 1: Study flow chart.

The demographic data, associated comorbidities (hypertension and GERD) and duration of diabetes in the two groups showed no statistically significant difference, as shown in Table (1).

In the LSG and SASI groups, the average operating time was 60.44±10.94 and 96.5±12.53 min, respectively, with a considerable increase in the SASI group (*P*< 0.001). The number of applied cartridges and distance from the pylorus showed a significant increase in the SASI group ($P< 0.001$). Bleeding from the short gastric vessels was encountered in only one patient in the LSG group (6.25%); no conversion to the open approach was required. Bleeding was noted in only one (6.25%) patient after the SASI procedure, and it was managed by intravenous fluids and blood transfusion. Transient or temporary postoperative vomiting was experienced in two (12.5%) cases in the LSG group. The incidence of intraoperative complications, postoperative complications, time to oral and duration of hospitalization were comparable between the two study groups ($P> 0.05$) (Table 1). Regarding plasma glucose parameters (fasting, postprandial, and random plasma glucose) and HbA1c, their levels showed a statistically significant decline in both study groups compared to the baseline. On comparing the two groups, no significant difference was noted either at baseline or at follow-up readings, as shown in Table (2).

Table 1: Patient demographics, operative and postoperative data (including complications) in the two study groups:

	LSG group (*N*= 16)	SASI group (*N*= 16)	*P* value
Age (years)	45.69±5.51	46.81±5.81	0.578
Sex			
Female	12 (75)	10(62.5)	0.446
Male	4 (25)	6(37.5)	
Comorbidities			
Hypertension	4 (25)	5(31.25)	0.694
Reflux	3 (18.75)	3(18.75)	1
BMI (kg/m^2)	46.02±5.18	44.85±5.11	0.191
Duration of diabetes (years)	7 (2–15)	8(2–15)	0.806
Operative time (min)	60.44±10.94	96.50±12.53	<0.001**
Number of cartridges	4(4–5)	5(5–6)	<0.001**
Distance from pylorus	4(2–4)	6(6–8)	<0.001**
Intraoperative complication			
Hemorrhage from short splenic vessels	1(6.25)	0	0.310
Conversion to open	0	0	1
Postoperative complications			
Leakage	0	0	1
Bleeding	0	1(6.25)	0.310
Transient vomiting	2(12.5)	0	0.144
Oral intake (day)	1(1–2)	1(1–2)	0.632
Hospital stay	2(2–3)	2(2–3)	0.987

LSG: Laparoscopic Sleeve Gastrectomy; SASI: Single Anastomosis Sleeve Ileal.

Table 2: Blood glucose parameters (fasting, postprandial, random plasma glucose, and glycosylated hemoglobin) changes, diabetes changes, and excess weight loss percentage changes in the two study groups:

	LSG group (*N*= 16)	SASI group (*N*= 16)	*P* value
Fasting			
Basal	120.19±11.6	119±10.16	0.761
3 months	106.81±5.66	107.44±6.80	0.779
P value	<0.001**	<0.001**	
6 months	98.63±8.66	97.38±8.12	0.677
P value	<0.001**	<0.001**	
9 months	96.88±7.52	96.75±8.46	0.965
P value	<0.001**	<0.001**	
12 months	94.38±9.15	94.75±10.48	0.915
P value	<0.001**	<0.001**	
Postprandial			
Basal	223.94±53.38	227.63±36.97	0.822
3 months	170.94±29.89	170.56±27.20	0.971

	LSG group (*N*= 16)	SASI group (*N*= 16)	*P* value
P value	<0.001**	<0.001**	
6 months	143.75±28.98	144.06±29.74	0.976
P value	<0.001**	<0.001**	
9 months	138.06±26.66	140.56±28.24	0.799
P value	<0.001**	<0.001**	
12 months	129.94±33.30	131.88±28.8	0.862
P value	<0.001**	<0.001**	
Random			
Basal	235.75±57.33	232.44±48.45	0.437
3 months	167.06±31.07	174.56±22.09	0.519
P value	<0.001**	<0.001**	
6 months	142.88±20.85	146.69±26.62	0.665
P value	<0.001**	<0.001**	
9 months	138.94±32.77	136±33.08	0.802
P value	<0.001**	<0.001**	
12 months	136.31±29.59	132.94±22.33	0.718
P value	<0.001**	<0.001**	
HbA1c			
Basal	7.57±0.75	7.58±0.75	0.981
3 months	6.89±0.54	7.05±0.48	0.373
P value	<0.001**	<0.001**	
6 months	6.18±0.45	6.12±0.53	0.749
P value	<0.001**	<0.001**	
9 months	5.64±0.79	5.71±0.70	0.778
P value	<0.001**	<0.001**	
12 months	5.56±0.48	5.51±0.61	0.799
P value	<0.001**	<0.001**	
Diabetes changes			
6 months			
Complete remission	7(43.75)	9(56.25)	0.853
Partial remission	4(25)	4(25)	
Improvement	3(18.75)	2(12.5)	
Unchanged	2(12.5)	1(6.25)	
12 months			
Complete remission	9(56.25)	10(62.5)	0.835
Partial remission	3(18.75)	4(25)	
Improvement	2(12.5)	1(6.25)	
Unchanged	2(12.5)	1(6.25)	
%EWL changes in the two study groups.			
3 months	27.38±8.27	26.49±10.65	0.794
6 months	43.21±9.22	40.95±11.63	0.548
P value	<0.001**	<0.001**	
9 months	53.79±7.54	54.58±10.90	0.814
P value	<0.001**	<0.001**	
12 months	65.79±5.36	68.18±10.31	0.417
P value	<0.001**	<0.001**	

%EWL: Excess Weight Loss Percentage; HbA1c: Glycosylated Hemoglobin; LSG: Laparoscopic Sleeve Gastrectomy; SASI: Single Anastomosis Sleeve Ileal.

Regarding the effect of both procedures on diabetic outcomes (glycemic control) as shown in Table (2), a positive impact was noticed in 87.5 and 93.75% of cases in the LSG and SASI groups, respectively, at 6-month follow-up visits. At the subsequent visit, the same effect was still present. Both groups were comparable regarding their effect on diabetes outcomes.

The %EWL showed a statistically significant increase with time in both study groups, and it was comparable between the two study groups (*P*> 0.05) as shown in Table (2).

Nutritional parameters changes are shown in Table (3): hemoglobin, ferritin, albumin, and calcium levels showed no significant changes after both procedures compared to the baseline levels and on comparing the two groups (*P*> 0.05), apart from: (a) 9- and 12-month albumin follow-up mean values which showed a statistical decrease compared to the baseline, but most of these values were within the normal serum albumin values and (b) the last recording of calcium mean levels in the SASI group (9.07mg/dl), which turned significantly lower than its baseline value (*P*= 0.032), but that decrease was clinically irrelevant as all of these values remained within the normal reported range.

Lipid profile changes are listed in Table (3). It was clear that both procedures significantly raised high-density lipoprotein (HDL) levels relative to the starting point and led to a significant drop in low-density lipoprotein, triglycerides, and cholesterol, but without statistically significant differences between the two groups.

Hypertension and GERD changes are listed in Table (4). Among the included hypertensive cases, a beneficial impact was noticed in 75 and 60% of cases in the LSG and SASI groups, respectively, with no significant difference noted between the two groups. In patients diagnosed with preoperative reflux, resolution or improvement was noticed after 1 year in all cases in the SASI group, while most of these cases reported worsening of their symptoms after LSG de novo GERD was reported by two (15.38%) LSG cases versus no cases in the SASI group (*P*= 0.141).

Table 3: Nutritional changes and lipid profile changes in the two study groups:

	LSG group (*N*= 16)	SASI group (*N*= 16)	*P* value
Hemoglobin			
Basal	13.05±1.02	13.04±1.13	0.974
3 months	13.07±0.97	13.25±0.92	0.605
P value	0.922	0.337	
6 months	13.21±0.88	12.74±1.07	0.186
P value	0.664	0.417	
9 months	12.53±0.86	12.51±0.87	0.968
P value	0.121	0.205	
12 months	12.46±0.91	12.33±0.95	0.692
P value	0.184	0.081	
Albumin			
Basal	4.15±0.18	4.19±0.22	0.549
3 months	4.16±0.18	4.11±0.14	0.170
P value	0.829	0.130	
6 months	4.03±0.16	4.06±0.17	0.099
P value	0.047*	0.083	
9 months	3.98±0.15	3.88±0.18	0.092
P value	0.027*	0.001*	
12 months	3.96±0.18	3.84±0.20	0.069
P value	0.006*	0.001*	
Calcium			
Basal	9.40±0.53	9.50±0.52	0.549
3 months	9.31±0.43	9.17±0.34	0.130
P value	0.578	0.086	
6 months	9.22±0.52	9.47±0.49	0.160
P value	0.288	0.894	
9 months	9.46±0.50	9.47±0.50	0.972

	LSG group (*N*= 16)	SASI group (*N*= 16)	*P* value
P value	0.683	0.881	
12 months	9.26±0.43	9.07±0.34	0.169
P value	0.510	0.032*	
Ferritin			
Basal	119.71±42.84	111.69±38.70	0.582
3 months	117.21±38.09	110.99±35.09	0.634
P value	0.214	0.0677	
6 months	116.12±34.19	113.04±37.64	0.811
P value	0.546	0.771	
9 months	105.83±38.73	107.63±50.49	0.911
P value	0.323	0.787	
12 months	106.36±33.87	101.14±35.80	0.675
P value	0.247	0.516	
Lipid profile changes			
HDL			
Basal	41.63±4.18	44.06±4.52	0.124
3 months	45.25±4.55	44.31±4.35	0.556
P value	0.002*	0.842	
6 months	46.31±3.65	45.69±3.96	0.646
P value	0.004*	0.292	
9 months	47.56±3.18	48.56±3.54	0.407
P value	0.001*	0.001*	
12 months	50.25±4.96	48.75±5.41	0.420
P value	0.001*	0.032*	
LDL			
Basal	114.88±38.83	114.25±33.53	0.961
3 months	103.06±17.7	102.38±21.38	0.922
P value	0.05*	0.003*	
6 months	99.63±13.33	97.25±13.30	0.618
P value	0.049*	0.010*	
9 months	93.44±12.75	94.13±10.43	0.869
P value	0.016*	0.008*	
12 months	94.50±12.40	95.50±13.96	0.832
P value	0.021*	0.017*	
TG			
Basal	166.81±42.70	162.63±36.24	0.767
3 months	156.25±26.43	157.50±28.75	0.899
P value	0.029*	0.179	
6 months	150.50±20.26	151.31±21.14	0.912
P value	0.016*	0.028*	
9 months	144.88±11.64	146.06±11.31	0.772
P value	0.017*	0.030*	
12 months	135.56±5.94	131.13±8.95	0.109
P value	0.014*	0.004*	
Cholesterol			
Basal	204.50±21.85	204.63±19.95	0.987
3 months	198.69±19.58	198.13±16.51	0.931
P value	0.007*	0.008*	
6 months	193.81±16.38	194.81±16.89	0.866
P value	0.001*	0.002*	

	LSG group (*N*= 16)	SASI group (*N*= 16)	*P* value
9 months	191.06±14.83	189.88±16.01	0.829
P value	0.001*	<0.001**	
12 months	192.31±14.75	187.81±15.32	0.404
P value	0.001*	<0.001**	

HDL: High-density Lipoprotein; LDL: Low-density Lipoprotein; LSG: Laparoscopic Sleeve Gastrectomy; SASI: Single Anastomosis Sleeve Ileal; TG: Triglyceride.

Table 4: Changes in comorbidities:

	LSG group (*N*= 4)	SASI group (*N*= 5)	*P* value
Hypertension			
6 months			
Complete remission	1(25)	1(20)	0.825
Partial remission	1(25)	1(20)	
Improvement	0	1(20)	
Unchanged	2(50)	2(40)	
12 months			
Complete remission	1(25)	1(20)	0.973
Partial remission	1(25)	1(20)	
Improvement	1(25)	1(20)	
Unchanged	1(25)	2(40)	
Reflux changes			
6 months			
Resolution	0	2(66.67)	0.135
Improvement	1(33.33)	1(33.33)	
Worsened	2(66.67)	0	
12 months			
Resolution	0	2(66.67)	0.135
Improvement	1(33.33)	1(33.33)	
Worsened	2(66.67)	0	
De novo GERD	2(15.38)	0	0.141

LSG: Laparoscopic Sleeve Gastrectomy; SASI: Single Anastomosis Sleeve Ileal.

DISCUSSION

Our trial handles the comparison between the effect of LSG and SASI procedures on weight loss and comorbidity resolution in obese patients with T2DM. To the best of our knowledge, there is a paucity of prospective clinical trials comparing the previous two techniques, which poses an advantageous point in favor of our study.

First and foremost, there were no noticeable differences between our two groups in terms of preoperative variables. This demonstrates that we employed proper randomization, which should help to reduce any bias that may have skewed our results in favor of one group over another.

In our study, we noted a significant increase in operative time in the SASI group compared to the LSG ($P< 0.001$). The increased operative time needed in the SASI group could be attributed to extra manoeuvres added to the SASI compared to LSG. These included counting, measuring the distance in bowel loops, creating a hole in the sleeve and small bowel, and performing the anastomosis. Likewise, other authors reported that SASI bypass required longer operative time than LSG (108.7 vs. 92.8min, respectively, ($P< 0.001$)[24].

In our study, bleeding was encountered in only one case in the SASI group, and it was successfully managed by intravenous fluid administration and blood transfusion. Another study reported the incidence of postoperative hemorrhage in one out of the 58 cases that underwent the SASI procedure[24]. Likewise, Kermansaravi *et al*.,[25] reported the occurrence of extraluminal bleeding in one out of the 24 SASI cases (4.17%).

In the current study, postoperative transient vomiting was experienced in two (12.5%) LSG cases, compared to no cases in the SASI group, with no significant difference between the two groups. This is in accordance with previous studies, which report the incidence of vomiting after LSG due to the decrease in gastric volume and increased intraluminal pressure[26]. On the other hand, the creation of a gastro-enteric anastomosis in the SASI group would help decrease intraluminal pressure, which would help decrease the incidence of this complication.

Short-term %EWL was comparable between the two procedures in our trial. It had mean values of 43.21 and 40.95% after 6 months and 65.79 and 68.18% after 1 year in the LSG and SASI groups, respectively. In our opinion, both procedures were efficacious in achieving short-term weight loss.

In the study conducted by Emile and colleagues, the %EWL had mean values of 43.4±11.2 and 46.2±14.3 in the LSG and SASI groups, respectively (P= 0.18). Nevertheless, 1-year findings showed the superiority of the SASI group. One-year %EWL had mean values of 60.4±12.5 and 72.6±14.03 in the same two groups, respectively, which was significant on statistical analysis (P< 0.001)[24].

Moreover, another study confirmed the superiority of the SASI procedure on %WL in the short term. The %WL had mean values of 57.9±27.5 and 80.2±52.9% at 6 months, 72.5±33.9 and 87.6±20.3 at 12 months for LSG and SASI groups, respectively (P< 0.001)[7].

Based on the previous facts, one should conclude that the SASI procedure had an additional hormonal and malabsorptive element compared to LSG and should explain its upper hand in weight loss outcomes in the previous two studies. However, this superiority was not obvious in our study, and this could be explained by the different afferent limb lengths used in different studies.

The heterogenicity in weight loss outcomes after SASI is evident in the current literature. Another study reported that the %EWL had a mean value of 63.9±29.5 at the 12-month follow-up after the SASI procedure[18]. Kermansaravi *et al*.,[25] reported that SASI 6 and 12 months mean %EWL values were 67.8±18.4 and 86.2±24.0%, respectively. Furthermore, another SASI study showed that %EWL was excellent; there were 75% at 6 months and 90% in the first year[17]. One could see the previous heterogenicity of the reported %EWL within the same follow-up duration. This could be explained by different preoperative BMI, different surgical techniques, different total bowel lengths, and different dietary and exercise regimens after surgery, among other studies.

In the current study, both LSG and SASI had a comparable beneficial impact on T2DM. This positive impact (remission or improvement) was noticed in 87.5 and 93.75% of cases in the same two groups, respectively, at 1-year follow-up. Based on the previous findings regarding diabetic changes, it would be realistic to detect a significant drop in all glycemic parameters, including blood glucose and HbA1c levels, and that was evident in our two groups.

In another study, at 1-year follow-up, remission or improvement of the same comorbidity was encountered in 70 and 95.8% of cases in the LSG and SASI groups, respectively, with significantly better diabetic outcomes in association with the SASI procedure (P= 0.03)[24].

Another study reported that the same outcome was obtained in 71.4 and 97.9% of patients in the LSG and SASI groups, respectively, with a significant statistical difference in favor of the SASI group (P= 0.04)[7]. The previous two studies reported significantly better weight loss outcomes in the SASI group, and that could explain their better glycemic outcomes.

Although SASI induced improvement of T2DM via restriction, malabsorption, and hormonal actions (increase in ileal hormones)[18,27,28], LSG is also a documented antidiabetic procedure, as previously reported in a previous Egyptian study which reported that all diabetic patients who underwent LSG either showed complete (25%) or partial remission (75%) 1 year after it[29].

Two Egyptian studies showed comparable effectiveness of LSG to other malabsorptive bariatric procedures in improving diabetic outcomes. One showed that complete diabetic remission was noted in 55% of cases in the both LSG and MGB groups (P= 0.076) 18 months after the procedures, and the other reported that 1-year follow-up revealed remission of diabetes in 66.2 and 79% of cases in the LSG and MGB groups, with no significant difference on statistical analysis (P= 0.243)[30,31].

In the current study, both bariatric procedures had a significant positive impact on hypertension, which was evident in 75 and 60% of cases in the LSG and SASI groups, respectively, with no significant difference between the two groups. Likewise, Emile and colleagues reported comparable hypertensive outcomes after the LSG and SASI procedures. Remission or improvement of hypertension was reported by 62.5 and 57.1% of cases in the LSG and SASI groups, respectively (P= 0.99)[24]. Moreover, Mahdy *et al.,*[7] reported improvement in hypertension in 64.3 and 75% of patients in the LSG and SASI groups, respectively, and that was also comparable between the two groups. The previous two studies confirmed our findings.

Regarding lipid profile changes in our study, we noted a significant improvement in all four lipid profile parameters, and that effect was comparable between the two procedures. A thorough review of the literature revealed that, other than the Mahdy and colleagues study, no other study had provided comprehensive laboratory values of the lipid profile following SASI. These authors reported a significant improvement in the four main lipid profile parameters within 1 year after the SASI procedure. Triglycerides, cholesterol, HDL, and LDL had mean values of 239.139, 266.82, 46.4, and 189.48 before operation, which changed to 106.28, 119.6, 112.14, and 81.2mg/dl 1 year after the operation (P< 0.05)[17]. The beneficial effect of LSG on lipid profile has also been discussed before, and remission or improvement of dyslipidaemia was reported in 83–100% of dyslipidemic cases after such a procedure[32,33].

In the current study, although both procedures showed statistically comparable outcomes in patients with preoperative reflux, all patients in the SASI group showed favorable changes, while most cases in the LSG group reported worsening of their symptoms. In addition, de novo reflux was noticed in 15.38% of LSG cases versus no cases with the SASI bypass. In a previous similar study, improvement of preoperative GERD was reported in 85.7% of patients after the SASI procedure, compared to only 18.2% of patients after LSG. That difference was significant on statistical analysis (P= 0.01)[24]. The same study reported that de novo GERD was experienced in seven (14.89%) cases after LSG.

In an additional study, GERD improvement had a higher incidence following the SASI procedure, as it was improved in seven (77.7%) out of nine cases versus one (50%) of two cases in the LSG group[7].

The etiology of worsening reflux after LSG could be explained by the increased intraluminal pressure and decreased lower esophageal sphincter pressure due to disruption of the angle of His[34,35]. However, gastroileal anastomosis in SASI could help to decrease this intraluminal pressure compared to LSG[36].

In the current study, both LSG and SASI procedures expressed comparable serum albumin levels at the follow-up visits. Even the decreased mean albumin values at follow-up remained in the normal reference range. Similarly, another study reported no significant effect on serum albumin levels between the two procedures. Preoperative and postoperative albumin had mean values of 3.6 and 3.7mg/dl in the LSG group, compared to 3.45 and 3.43mg/dl in the SASI group. Postoperative measurements were obtained 1 year after the operation in that study[7]. This study reported the incidence of hypoalbuminemia in nine (12.16%) of the 74 patients who underwent the SASI procedure.

Mahdy and colleagues noticed no significant changes in serum albumin within 1 year after the SASI procedure (P= 0.92). It had mean values of 3.39±0.28 and 3.38±0.66 before and after the procedure, respectively[37].

In the current study, there were no discernible differences in the changes in hemoglobin levels between the two approaches. Given that iron shortage is the most frequent cause of anemia following bariatric surgery[38,39], stable iron profiles in the form of ferritin and the maintenance of the duodenal route may assist in explaining normal hemoglobin levels. This was also shown by serum ferritin levels, which did not significantly decline in the SASI group.

Serum calcium levels in our research did not significantly alter as a result of either procedure. In a similar vein, Saif *et al.*,[40] disclosed that LSG had a crucial effect on blood calcium levels throughout the 1-year follow-up. Because the duodenum, being the primary site of calcium absorption, is not bypassed during a sleeve gastrectomy, calcium levels are maintained[41]. Mahdy and colleagues found that calcium levels had mean values of 8.8, 9.2, and 9.2mg/dl prior to the procedure, 3 months after it, and 6 months following it, respectively. This was also observed with the SASI technique. According to statistical analysis, serum calcium was not significantly affected by the procedure (P= 0.069)[17].

There are some issues with the current study. It was carried out using a small sample size at a single surgical facility. Long-term and intermediate-term follow-up data are also absent. Future research should thoroughly address the earlier disadvantages.

CONCLUSION

Based on the preceding findings, both LSG and SASI procedures have comparable short-term outcomes regarding improvement of the diabetic state and weight loss, along with other obesity-related comorbidities.

CONFLICT OF INTEREST

There are no conflicts of interest.

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