Retrospective Cohort Study Comparing Laparoscopic One Anastomosis Gastric Bypass and Single Anastomosis Sleeve Ileal for the Treatment of Patients with Morbid Obesity and Effect on GLP-1 level: Short Term Outcomes

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Introduction: Bariatric surgery is an effective treatment for morbid obesity, though the optimal procedure remains debated. Laparoscopic one-anastomosis gastric bypass (LOAGB) and single-anastomosis sleeve ileal (SASI) bypass differ in their metabolic effects, particularly regarding glucagon-like peptide-1 (GLP-1), a key regulator of glycemic control.

Aim of work: To compare the impact of LOAGB and SASI on weight loss, glycemic improvement, GLP-1 levels, diabetes remission, comorbidity resolution, and postoperative complications.

Patients and methods: This retrospective cohort study included patients with severe obesity who underwent LOAGB or SASI. Outcomes at 12 months included %EWL, %EBMIL, HbA1c reduction, GLP-1 response, comorbidity resolution, and complications.

Results: Both groups achieved significant weight loss with no difference in %EWL (80.9% vs. 81.2%, $p = 0.738$) or %EBMIL (93.7% vs. 92.8%, $p = 0.285$). GLP-1 levels (pmol/L) at 6 months were significantly higher in SASI (11.63 vs. 10.48 pmol/L, $p = 0.01$). HbA1c decreased in both groups (LOAGB: 10.46% to 5.90%; SASI: 9.89% to 5.12%, $p = 0.461$). GLP-1 positively correlated with weight loss ($r = 0.74$) and inversely with HbA1c ($r = -0.79$), more pronounced in SASI. Diabetes remission was higher in SASI (100% vs. 87.5%), as was hypertension resolution (100% vs. 88.9%). Complication rates, operative time, and hospital stay were similar.

Conclusion: LOAGB and SASI both provide effective weight loss and metabolic improvements. SASI yields higher GLP-1 levels and superior diabetes remission, suggesting enhanced metabolic benefits. Further studies are needed to confirm long-term outcomes.

Key words: Glycemic control, one-anastomosis gastric bypass, single anastomosis sleeve ileal bypass, weight loss, glucagon-like peptide-1.

Introduction

Bariatric surgery is the most effective treatment for morbid obesity, offering significant and sustained weight loss, improvement in obesity-related comorbidities, and enhanced survival rates. Beyond restrictive and malabsorptive mechanisms, modern bariatric procedures increasingly leverage metabolic and neuroendocrine changes, including alterations in glucagon-like peptide-1 (GLP-1).[1,2]

GLP-1 is an incretin hormone secreted by L-cells in the distal ileum and colon in response to nutrient intake. It enhances insulin secretion, suppresses glucagon release, delays gastric emptying, and promotes satiety, making it a crucial factor in diabetes remission and appetite regulation post-surgery. Increased GLP-1 levels following bariatric procedures are associated with improved glucose homeostasis, reduced postprandial glycaemia, and decreased appetite, leading to both metabolic and weight loss benefits. However, the degree to which different surgical techniques influence GLP-1 secretion remains a subject of ongoing investigation.[3,4]

Laparoscopic one-anastomosis gastric bypass (LOAGB) and single-anastomosis sleeve ileal (SASI) bypass are two bariatric procedures gaining prominence.[5,6] LOAGB, an established alternative to Roux-en-Y gastric bypass, is a combination of gastric restriction and intestinal malabsorption, LOAGB creates a long gastric pouch and bypasses the proximal jejunum, altering nutrient exposure to the small intestine. Conversely, SASI, a novel metabolic procedure inspired by Santoro's bipartition technique, includes sleeve gastrectomy to restrict food intake, followed by a gastro-ileal anastomosis that allows partial nutrient flow through the normal duodenal pathway. Unlike LOAGB, SASI preserves proximal intestinal continuity, potentially enhancing GLP-1 secretion by allowing dual-pathway nutrient exposure-a mechanism hypothesized to improve metabolic outcomes while reducing the risk of nutritional deficiencies.[7-9]

Prior research has highlighted the role of GLP-1 in diabetes remission and appetite regulation, yet it remains unclear whether SASI offers a distinct advantage over LOAGB in terms of hormonal response. Additionally, while weight loss metrics

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such as BMI reduction, %EWL, and %EBMIL are well-established, comparative analyses between these procedures in the context of short-term postoperative outcomes require further exploration.[10,11]

This study aims to compare the short-term outcomes of OAGB and SASI in patients with morbid obesity, focusing primarily on glycemic improvement, weight loss, and metabolic outcomes. A particular emphasis is placed on GLP-1 elevation, diabetes remission, comorbidity resolution, and postoperative complications, providing new insights into the metabolic effects of these two bariatric procedures.

Patients and methods

Design, setting, and date: This retrospective study analyzed the records of 79 consecutive class V obese patients who underwent either LOAGB procedure (n=42) or SASI procedure (n=37) from January 2021 to December 2023 at the General Surgery Department of Alexandria University Hospital and some non-governmental hospitals.

Ethical considerations: This study was approved by the Institutional Review Board (IRB) and conducted in accordance with the ethical principles outlined in the Declaration of Helsinki (1975, updated 2013). Written informed consent was obtained from all patients prior to the procedures, ensuring their anonymity and confidentiality. The retrospective nature of the study eliminated the need of ethical patient approval. Institutional ethics review board approval was obtained prior to data collection.

Participants: In accordance with our institute policy, patients and procedures were selected for bariatric surgery based on the following criteria:

Inclusion criteria

a. Adults aged 18–65 years, diagnosed with morbid obesity (BMI ≥40 kg/m² or BMI ≥35 kg/m² with obesity-related comorbidities) and underwent LOAGB or SASI bypass.

b. Completion of at least 12 months of follow-up.

c. The patient must have failed to adhere to supervised conservative management for obesity for at least 6 months.

d. Patient’s willingness to undergo prolonged follow-up sessions with the surgeon and nutritionist.

Exclusion criteria

a. History of prior bariatric surgery.

b. Presence of major psychiatric disorders.

c. Severe cardiopulmonary or renal disease contraindicating surgery, c) Eating disorder (Including binge eating), which were excluded upon final analysis.

d. Patients with acute systemic infections.

e. Patients with a general contraindication for laparoscopy.

f. Lost to follow-up before the 12-month assessment.

g. Missing perioperative or follow up data.

Study endpoints and definitions: In the context of this study comparing LOAGB and SASI bypass in patients with morbid obesity, the primary endpoint is weight loss efficacy. This is assessed through metrics such as body mass index (BMI) reduction, percentage of excess weight loss (%EWL), and percentage of excess BMI loss (%EBMIL) at 3, 6, and 12 months postoperatively.

The secondary endpoints encompass a range of additional outcomes to provide a comprehensive evaluation of the procedures:

1. **Metabolic improvements:** A) Glycemic Control: Changes in HbA1c levels and fasting glucose concentrations. B) GLP-1 Response: GLP-1 levels were measured at 30 minutes postprandially using a commercially available ELISA kit (Millipore) according to the manufacturer’s instructions. Blood samples were collected preoperatively, and at 3 and 6 months postoperatively. C) Resolution of Hypertension and Dyslipidemia: Assessment of improvements or remission of these conditions.

2. **Perioperative safety and complications:** Monitoring of intraoperative events, early and late postoperative complications, and duration of hospital stay.

3. **Postoperative quality of life.**

The endpoints parameters were defined according to the standardized outcomes reporting in metabolic and bariatric surgery.[1]

Surgical procedures: A dedicated bariatric surgical team, composed of a senior bariatric surgeon with two bariatric surgeon assistants, performed all procedures under general anesthesia in the French operative position.

a. **The SASI operation:** The stomach is tabularized over a 36-French calibration tube. A wide sleeve gastrectomy was then perrfomed, and then the selected intestinal loop (250–300 cm proximal to the ileocecal junction) was brought up to the gastric sleeve. A linear cutting stapler was used to perform an isoperistaltic side-to-side anastomosis to the anterior wall of the stomach antrum (Two cm from the pylorus). The anastomosis diameter did not exceed 3-4 centimeters. Then, the anterior wall of the gastroileal anastomosis was closed by running sutures using V-Lock 2/0.

b. The LOAGB operation, also known as mini-gastric bypass, is designed to create a long, narrow gastric pouch that facilitates restrictive weight loss while establishing a loop gastrojejunostomy to induce malabsorption.

   1. **Gastric pouch creation:** After establishing pneumoperitoneum and placing trocars as per standard laparoscopic protocol, the lesser curvature of the stomach was identified. To access the lesser sac, a window was created in the lesser omentum near the incisura angularis. A 36-French bougie was positioned along the lesser curvature to guide the stapling process. Sequential firings of a linear stapler were used to divide the stomach vertically, starting from the antrum and extending towards the angle of His, resulting in a tubular gastric pouch approximately 15–20 cm in length.

   2. **Gastrojejunostomy:** The small intestine was measured from the ligament of Treitz, and a loop of jejunum located 200 cm distal to the ligament was identified. An antecolic, isoperistaltic side-to-side gastrojejunostomy was constructed between the gastric pouch and the selected jejunal loop using a linear stapler, forming a single anastomosis. The enterotomy was closed with a double-layer suture technique to ensure integrity.

For both procedures, an intraoperative methylene blue test was executed. An abdominal drain near the gastric staple line was inserted. Both procedures were concluded by verifying hemostasis, removing the bougie, and closing the port sites in layers. Patients were extubated in the operating room upon meeting standard criteria and transferred to the recovery unit for postoperative monitoring.

Postoperative care and follow-up: All patients were kept NPO (Nothing per mouth) until they underwent a gastografin swallow X-ray study to rule out leaks. If there were no leaks, patients began taking oral fluids immediately after the test on postoperative day two. If there were no complications, the patients were discharged on a liquid diet for two weeks and the drain was removed before discharge.

Nutritionists monitored the patients' diet progression. A) Weeks 1–4: Full liquids or pure solids, such as mashed potatoes and applesauce. B) Week 5: Soft foods, such as rice and overcooked vegetables. C) Week 6: Regular foods, such as chicken and bread, should be consumed. D) Week 7: More regular foods. Exercise involved walking for 30 minutes daily and participating in normal daily activities as tolerated. Upon the nutritionist's prescription, all patients received oral multivitamins, calcium and iron supplements starting from the second postoperative week until they resumed regular food intake (With follow up laboratory investigations withdrawn on demand according to the patient's clinical status).

Sample size: The required sample size was estimated using G*Power 3.1.9.2, based on an expected difference in BMI, %EWL, and GLP-1 levels between groups. Using a power of 80% (A=0.05), the minimum required sample was 79 patients (42 LOAGB, 37 SASI), ensuring adequate statistical power.

Statistical analysis

All statistical analyses were performed using SPSS version 21 (IBM, USA). Shapiro-Wilk test was used to assess data normality. Continuous variables (E.g., BMI, HbA1c) were reported as mean ± standard deviation (SD) and compared using Student's t-test. Categorical variables (E.g., remission rates) were expressed as frequencies (%) and analyzed using Chi-square or Fisher's exact test. Correlations between GLP-1, weight loss, and HbA1c were analyzed using Pearson's correlation coefficient (R-value). A p-value < 0.05 was considered statistically significant.

Results

A total of 79 patients were included in the study, with 42 patients undergoing LOAGB and 37 patients receiving SASI bypass.

A) The baseline characteristics of both groups (Table 1): Were comparable in terms of age (LOAGB: 40.7±9.3 vs. SASI: 39.2±8.7 years, p=0.46) and gender distribution (LOAGB: 76.2% female vs. SASI: 67.6% female, p=0.39). However, preoperative BMI was significantly higher in the SASI group (50.5±4.2 vs. 48.1±4.7, p=0.022). Similarly, the waist-to-hip (W/H) ratio was significantly lower in the SASI group (0.89±0.03 vs. 0.91±0.04, p=0.007).

Baseline GLP-1 levels and obesity-related comorbidities, including diabetes mellitus (DM), hypertension (HTN), and hyperlipidemia, were comparable between both groups (p>0.05).

LOAGB: One-anastomosis gastric bypass; SASI: single anastomosis sleeve jejunal bypass; W/H: waist hip ratio; GLP-1: glucagon like peptide 1; BMI: body mass index; SD: standard deviation.

P-values are based on the independent-test, chi-square test, Monte carlo and Fisher exact test. *Statistical significance at p< 0.05.

B) Operative and postoperative outcomes (Table 2):

1. The mean operative time was similar between groups (LOAGB: 115±19.2 min vs. SASI: 110±17.7 min, p=0.267).

2. Hospital stay duration showed no significant difference (Median 2 [2–14] vs. 2 [2–5] days, p=0.592).

3. Intraoperative complications occurred in 7.1% (LOAGB) vs. 8.1% (SASI) (P=1.000), with no major surgical complications requiring conversion to open surgery.

   In one LOAGB case, bleeding from the omentum was encountered due to fragile, engorged vessels in a high-BMI patient; hemostasis was achieved with bipolar diathermy and vascular clips. Another LOAGB case experienced a stapler misfire during gastric pouch creation, requiring reinforcement with an additional staple line.

   Among SASI cases; one patient with prior abdominal surgery developed a small serosal tear during ileal loop measurement, which was promptly repaired with an absorbable running suture. Minor bleeding from the upper pole of the spleen was noted in one SASI patient due to traction on the short gastric vessels, effectively controlled using hemostatic gauze. Additionally, a stapler malfunction at the gastro-ileal anastomosis resulted in incomplete closure, necessitating reinforcement with a hand-sewn suture, confirmed with a negative methylene blue leak test.

4. complications were classified according to the onset into early (Within 30 days of the operation) and late complications (Beyond 30 days postoperatively).

   a. Early postoperative complications (<1 month) were comparable (p = 0.679); occurred in 9.5% of LOAGB cases (4 patients) and 5.4% of SASI cases (2 patients). In the LOAGB group, complications included intraluminal bleeding managed with endoscopic clipping and blood transfusion, an anastomotic leak treated conservatively, repeated vomiting requiring intravenous hydration, and seroma formation managed with ultrasound-guided aspiration. In the SASI group, one patient developed a localized anastomotic leak resolved with bowel rest and parenteral nutrition, and another experienced postprandial vomiting due to gastric outlet edema, which improved with antiemetics and dietary adjustments. These findings emphasize the need for prompt recognition and management of complications to ensure successful recovery."

   b. Late postoperative complications (>1 month) were slightly higher in the SASI group (9.5% vs. 16.2%, p = 0.502), though not statistically significant. In the LOAGB group, complications included anemia treated with intravenous iron, cholelithiasis requiring laparoscopic cholecystectomy, an incisional hernia repaired with laparoscopic hernioplasty. In the SASI group; four patients developed symptomatic gallstones (Managed by laparoscopic cholecystectomy), one patient experienced protein malnutrition with dumping syndrome (Managed with dietary interventions), one patient reported biliary reflux (Resolved with proton pump inhibitors and dietary adjustments).

5. Concomitant operations were not significantly different between the procedures. 10% of the patients in the SASI group underwent extra-port insertion.

C) Weight loss outcomes (Table 3):

At all follow-up points (3, 6, and 12 months), both procedures resulted in significant weight reduction. At 3 months, the BMI reduction was significantly greater in LOAGB patients (39.0±4.1 vs. 41.1±2.8, p=0.011). At 6 months, LOAGB continued to show a significantly lower BMI (33.1± 2.9 vs. 35.3±2.4, p<0.001). However, at 12 months, the difference was no longer statistically significant (26.5± 1.1 vs. 26.9±1.1, p=0.150).

Percentage Excess Weight Loss (%EWL) and Percentage Excess BMI Loss (%EBMIL): %EWL at 3 months was significantly higher in LOAGB (34.5± 6.1 vs. 32.3±3.2, p = 0.046). %EWL at 6 months also favored LOAGB (56.6±5.5 vs. 52.1±3.9, p<0.001). However, at 12 months, %EWL was comparable (80.9%±3.3 vs. 81.2%±3.5, p=0.738). Similarly, %EBMIL at 12 months was also statistically equivalent (93.7%±3.9 vs. 92.8%±3.8, p=0.285).

This suggests that while LOAGB led to faster initial weight loss, both procedures achieved equivalent weight loss at 12 months.

D) Comorbidities improvement (Table 4): SASI procedure resulted in 100% hypertension remission, while LOAGB resulted in 88.9% remission (P=0.12, not significant). Diabetes remission was achieved in 100% of SASI patients, compared to 87.5% of LOAGB patients, reflecting the superior metabolic effect of SASI, although the difference did not reach statistical significance (P=0.214). Dyslipidemia and Other Comorbidities: Both groups showed significant improvements in dyslipidemia, obstructive sleep apnea, and venous disease, with no significant differences.

E) Metabolic outcomes and GLP-1 response (Table 5):

Postoperative metabolic outcomes demonstrated significant improvements in GLP-1 levels, glycemic control, and diabetes remission in both groups, with notable differences favoring SASI. At 3 months postoperatively, GLP-1 levels significantly increased in both groups, but the SASI group exhibited a greater elevation (10.47 ± 0.80 pmol/L) compared to LOAGB (9.17±0.97 pmol/L, p<0.001). This trend persisted at 6 months, where GLP-1 levels continued to rise (SASI: 11.63±1.06 vs. OAGB: 10.48±0.84, p<0.001).

These hormonal changes were associated with significant HbA1c reduction, demonstrating improved glycemic control in both groups. At 3 months, HbA1c levels decreased from preoperative values of 10.46%±1.12 to 8.13%±0.56 in OAGB and from 9.89%±1.22 to 7.79%±0.97 in SASI (P=0.228). At 6 months, HbA1c further dropped to 5.90%± 0.63 in OAGB and 5.12%±0.85 in SASI, with a significant difference favoring SASI (P=0.005).

Correlation analysis **(Table 6, Fig. 1)** demonstrates that SASI exhibits a stronger metabolic impact compared to LOAGB. In SASI, GLP-1 levels positively correlated with %EWL at both 3 and 6 months. However, this correlation was weaker and non-significant in the LOAGB group.

These findings emphasize the superior incretin response of SASI, which likely plays a critical role in its enhanced metabolic outcomes, particularly in achieving complete diabetes remission. While both procedures effectively improved glycemic control, the higher GLP-1 levels in SASI suggest a stronger neurohormonal effect, making it a favorable choice for metabolic surgery.

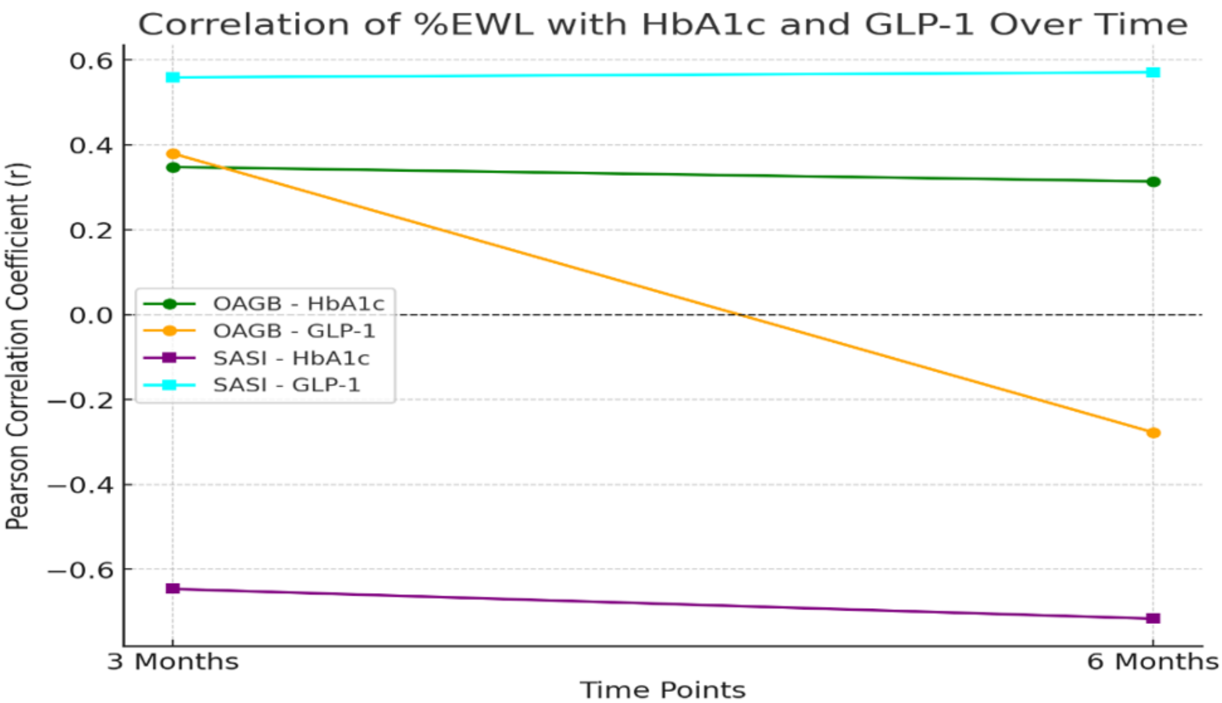

Fig 1: Correlation of % excess weight loss (%EWL) with HbA1c and GLP-1 levels in OAGB and SASI patients over 3 and 6 months for DM patients.

Table 1: Comparison between the two studied groups according to baseline characteristics

	LOAGB (n = 42)	SASI (n = 37)	P
Sex			
Male	10 (23.8%)	12 (32.4%)	0.394
Female	32 (76.2%)	25 (67.6%)	
Age (years)	40.71 ± 9.26	39.22 ± 8.73	0.463
Weight (kg)	134 ± 15.14	144 ± 15.41	0.003*
Height (cm)	167 ± 7.23	169 ± 6.13	0.121
BMI (kg/m^2)	48.12 ± 4.65	50.48 ± 4.25	0.022*
Excess weight	73.82 ± 12.58	82.96 ± 13.42	0.003*
W/H ratio	0.91 ± 0.04	0.89 ± 0.03	0.007*
GLP-1	2.17 ± 0.50	2.32 ± 0.49	0.192
Medical history	25 (59.5%)	33 (89.2%)	0.003*
DM	16 (38.1%)	18 (48.6%)	0.344
HTN	9 (21.4%)	11 (29.7%)	0.397
Menstrual Problems	2 (4.8%)	4 (10.8%)	0.411
Orthopaedic problem	5 (11.9%)	3 (8.1%)	0.717
Stress incontinence	1 (2.4%)	0 (0.0%)	1.000
Venous system disease	1 (2.4%)	4 (10.8%)	0.180
Hyperlipidaemia	2 (4.8%)	3 (8.1%)	0.661
Polycystic Ovary	0 (0.0%)	2 (5.4%)	0.216
Hypothyroidism	0 (0.0%)	2 (5.4%)	0.216
Infertility	0 (0.0%)	1 (2.7%)	0.468
Obstructive sleep apnea	1 (2.4%)	2 (5.4%)	0.597
Surgical history	23 (54.8%)	27 (73.0%)	0.094
Ceserian section	13 (31.0%)	13 (35.1%)	0.693
Cholecystectomy	2 (4.8%)	7 (18.9%)	0.075
Lumbar disk surgery	1 (2.4%)	0 (0.0%)	1.000
Hysterectomy	1 (2.4%)	2 (5.4%)	0.597
Amputation	1 (2.4%)	0 (0.0%)	1.000
Hip replacement	1 (2.4%)	0 (0.0%)	1.000
Appendectomy	4 (9.5%)	8 (21.6%)	0.135
Abdominoplasty	1 (2.4%)	0 (0.0%)	1.000
Bilateral mastectomy	1 (2.4%)	0 (0.0%)	1.000
Inguinal hernia repair	2 (4.8%)	1 (2.7%)	1.000
Paraumbilical hernia repair	1 (2.4%)	3 (8.1%)	0.336
Right breast fibro adenoma	0 (0.0%)	1 (2.7%)	0.468
Dietary habits			
Night eaters	4 (9.5%)	1 (2.7%)	0.010*
Atypical eating disorder	8 (19%)	0 (0%)	
Sweet eater	8 (19%)	8 (21.6%)	
Bulk eater	22 (52.4%)	28 (75.7%)	
Preoperative quality of life			
Poor	32 (78%)	30 (81.1%)	0.741
Fair	9 (22%)	7 (18.9%)	

Data are presented as mean ± SD or number of patients and percentage.

Table 2: Comparison between the two studied groups according to operative and post-operative data

	LOAGB (n = 42)	SASI (n = 37)	P
Time of operation (Min)	115 ± 19.17	110 ± 17.7	0.267
Hospital stay (Day)	2 (2 – 14)	2 (2 – 5)	0.592
Complications			
Intraoperative complications	3 (7.1%)	3 (8.1%)	1.000
Bleeding from Omentum	1 (2.4%)	0 (0%)	1.000
Bleeding from upper pole of spleen	0 (0%)	1 (2.7%)	0.468
Broken stapler during stapling	1 (2.4%)	0 (0%)	1.000
Injured bowel loop	1 (2.4%)	1 (2.7%)	1.000
Misfired reload	0 (0%)	1 (2.7%)	0.468
Early Postoperative Complications (<1 month)	4 (9.5%)	2 (5.4%)	0.679
Postoperative bleeding	0 (0%)	1 (2.7%)	0.468
Leakage	2 (4.8%)	0 (0%)	0.496
Repeated vomiting	1 (2.4%)	1 (2.7%)	1.000
Seroma	1 (2.4%)	0 (0%)	1.000
Late Postoperative Complications (>1 month)	4 (9.5%)	6 (16.2%)	0.502
Anaemia	1 (2.4%)	0 (0%)	1.000
Cholelethiasis	2 (4.8%)	4 (10.8%)	0.411
Port site incisional hernia	1 (2.4%)	0 (0%)	1.000
Protein malnutrition with dumping	0 (0%)	1 (2.7%)	0.468
Biliary Reflux	0 (0%)	1 (2.7%)	0.468
Concomitant procedure	5 (11.9%)	5 (13.5%)	1.000
Cholecystectomy	3 (7.1%)	3 (8.1%)	1.000
Inguinal hernia repair	1 (2.4%)	0 (0%)	1.000
Pelvic adhesolysis	1 (2.4%)	2 (5.4%)	0.597
Extra-port insertion	–	3 (10.0%)	–

Data are presented as mean ± SD, median (Minimum-maximum), or number of patients and percentage. LOAGB: one-anastomosis gastric bypass; SASI: Single anastomosis sleeve jejunal bypass; SD: standard deviation; min: Minutes. p-values are based on the student t-test, chi-square test, Mann Whitney test, and Fisher exact test.

Table 3: Comparison between the two studied groups according to body weight changes

	LOAGB (n = 42)	SASI (n = 37)	P
BMI (kg/m²)			
Preoperative	48.12 ± 4.65	50.48 ± 4.25	0.022*
After 3 months	39.02 ± 4.07	41.06 ± 2.76	0.011*
After 6 months	33.13 ± 2.86	35.35 ± 2.36	<0.001*
After 1 year	26.53 ± 1.13	26.89 ± 1.09	0.150
P-value	<0.001*	<0.001*	
W/H ratio			
Preoperative	0.91 ± 0.04	0.89 ± 0.03	0.007*
After 6 months	0.85 ± 0.04	0.82 ± 0.03	<0.001*
After 1 year	0.78 ± 0.02	0.77 ± 0.03	0.025*
P-value	<0.001*	<0.001*	
% EWL			
After 3 months	34.52 ± 6.12	32.32 ± 3.22	0.046*
After 6 months	56.55 ± 5.54	52.12 ± 3.85	<0.001*
After 1 year	80.92 ± 3.28	81.17 ± 3.47	0.738
P-value	<0.001*	<0.001*	
% EBMIL			
After 3 months	40.10 ± 7.76	36.97 ± 3.95	0.025*
After 6 months	65.62 ± 7.77	59.61 ± 4.72	<0.001*
After 1 year	93.74 ± 3.93	92.80 ± 3.81	0.285
P-value	<0.001*	<0.001*	

Quantitative data was expressed by using Mean ± SD., Qualitative data was expressed by using No. (%).

Statistically significant at $p \le 0.05$.

Table 4: Comparison between the two studied groups according to co-morbidities

	LOAGB	SASI	χ^2	^{FE}P
Co-morbidities				
DM	**(n = 16)**	**(n = 18)**		
Cured	14 (87.5%)	18 (100.0%)	2.391	0.214
Improved	2 (12.5%)	0 (0%)		
HTN	**(n = 9)**	**(n = 11)**		
Cured	8 (88.9%)	11 (100.0%)	1.287	0.450
Improved	1 (11.1%)	0 (0%)		
Cured venous disease	1 (100%)	4 (100%)	0.000	1.000
Cured hyper lipidemia	2 (100%)	3 (100%)	0.000	1.000
Cured incontinence	1 (100%)	0 (100%)	0.000	1.000
Cured menstruation	1 (100%)	4 (100%)	0.000	1.000
Cured orthopedic problems	5 (100%)	3 (100%)	0.000	1.000
Cured apnea	1 (100%)	2 (100%)	0.000	1.000
Stop el–troxin	–	2 (100%)	–	–

x2: Chi square test. FE: Fisher Exact test.

p: p value for comparing between the two studied groups.

Table 5: Comparison between the two studied groups according to glycemic improvement postoperatively

	LOAGB (n = 42)	SASI (n = 37)	Test of Sig.	P
HbA1c	**(DM n = 16)**	**(DM n = 18)**		
Preoperative	10.46 ± 1.12	9.89 ± 1.22	t=1.407	0.169
After 3 months	8.13 ± 0.56	7.79 ± 0.97	t=1.234	0.228
After 6 months	5.90 ± 0.63	5.12 ± 0.85	t=3.006*	0.005*
p_1	<0.001*	<0.001*		
GLP-1 (pmol/l)				
Preoperative	2.17 ± 0.50	2.32 ± 0.49	t=1.317	0.192
After 3 months	9.17 ± 0.97	10.47 ± 0.80	t=6.511*	<0.001*
After 6 months	10.48 ± 0.84	11.63 ± 1.06	t=5.409*	<0.001*
p_1	<0.001*	<0.001*		

Quantitative data was expressed by using Mean ± SD.

SD: Standard deviation t: Student t-test x2: Chi square test

Statistically significant at p ≤ 0.05.

Table 6: Correlation between % EWL with HbA1c and GLP-1(pmol/L) in each group (In diabetic patient only)

	% EWL	No.	3 Months		6 Months	
			R	P	R	P
LOAGB (n = 42)	HbA1c	16	0.348	0.186	0.314	0.236
	GLP-1	16	0.380	0.146	-0.277	0.299
SASI (n = 37)	HbA1c	18	-0.646*	0.004*	-0.716*	0.001*
	GLP-1	18	0.559*	0.016*	0.571*	0.013*

R: Pearson coefficient.

Discussion

Bariatric surgery remains the most effective intervention for long-term weight management and metabolic improvement in patients with severe obesity. Over recent years, different surgical techniques have been developed, each with its own advantages and limitations. LOAGB and SASI bypass have demonstrated remarkable weight loss and metabolic benefits, but their effects on diabetes remission and GLP-1 secretion remain key areas of interest.[9,11-15] The current study compares LOAGB and SASI bypass, focusing on their impact on weight loss, GLP-1 secretion, glycemic control, and overall metabolic outcomes.

At baseline, although both groups shared similar age and gender distribution, the SASI group had significantly higher preoperative BMI, weight, and different W/H ratios.

In our study, both procedures resulted in significant weight loss over 12 months, with comparable reductions in BMI, %EWL, and %EBMIL. Although OAGB initially led to faster weight loss (Significantly greater BMI reduction at 3 and 6 months), this difference was no longer evident at 12 months. The %EWL and %EBMIL at 12 months were nearly identical between both groups, indicating that both procedures provide sustained weight reduction over time. This aligns with previous research showing that SASI and OAGB are equally effective in long-term weight loss, despite potential differences in metabolic outcomes.[16,18-21]

A key finding of this study is the significantly greater GLP-1 elevation in the SASI group compared to LOAGB. At 3 months postoperatively, GLP-1 levels were higher in SASI (10.47±0.80 pmol/L) than in LOAGB (9.17±0.97 pmol/L, p<0.001), and this trend continued at 6 months (SASI: 11.63±1.06 vs. LOAGB: 10.48 ± 0.84, p<0.001). This enhanced GLP-1 response in SASI was correlated with better glycemic control and diabetes remission. HbA1c levels decreased significantly in both groups, but SASI patients exhibited a stronger correlation between GLP-1 elevation and glycemic improvement (R=-0.716, p=0.001 at 6 months), suggesting that the superior incretin effect in SASI contributes to better diabetes remission rates.

The mechanism behind these findings is rooted in gut hormone physiology. The SASI procedure allows food to bypass part of the small intestine while preserving partial duodenal passage, leading to dual stimulation of proximal and distal gut hormone secretion. This enhances L-cell stimulation in the distal ileum, leading to greater GLP-1 secretion, improved insulin sensitivity, and better postprandial glucose regulation. In contrast, LOAGB also increases

GLP-1 secretion, but its lack of bipartitioned nutrient exposure may result in slightly lower incretin stimulation. These results support the hypothesis that gut hormone modulation plays a key role in diabetes remission following bariatric surgery.[7,10,22]

According to the researchers' hypothesis, an ideal bariatric operation must promote weight loss via functional restriction as well as regulating the patient's neuroendocrine control of both their satiety and appetite, as an alternative to malabsorption and mechanical restriction. The work of Santoro and colleagues has described the technique of digestive adaptation.[5] Following the bi-partition procedures, the neuroendocrine response can primarily cause weight loss. This neuroendocrine response stimulates the early reception of nutrients as well as the secretion of satietogenic hormones within the distal bowel. Also, it induces a satiety sensation mediated by the hypothalamus and reduces the proximal bowel activity.[22] This neuroendocrine response is considered the main reason for improving glycosylated hemoglobin levels after both bypass procedures: either LOAGB or SASI.

The mechanism behind these findings is rooted in gut hormone physiology. The SASI procedure allows food to pass through both the sleeve gastrectomy pathway and the distal ileal loop, leading to enhanced nutrient exposure to L-cells in the distal small intestine. This results in greater GLP-1 secretion, amplifying the incretin effect, improving insulin sensitivity, and enhancing postprandial glucose regulation. In contrast, LOAGB also elevates GLP-1 levels, but the lack of a bipartitioned pathway may lead to slightly lower stimulation of distal L-cells. These findings support the hypothesis that gut hormone modulation plays a significant role in diabetes remission post-bariatric surgery.[14-20,23]

At 12 months postoperatively, complete diabetes remission was achieved in 100% of SASI patients compared to 87.5% in the OAGB group, although this difference did not reach statistical significance (P=0.214). The relationship between weight loss and diabetes remission remains complex. While both groups exhibited similar long-term weight loss, the superior GLP-1 response in SASI suggests that metabolic factors beyond weight reduction contribute to diabetes remission. This further supports the concept that bariatric surgery is not merely a restrictive-malabsorptive procedure but a neurohormonal metabolic surgery.

Similarly, hypertension remission was higher in SASI (100%) compared to OAGB (88.9%), reinforcing the potential metabolic advantage of SASI over OAGB. These findings are consistent with prior studies demonstrating that SASI provides superior glycemic control due to its enhanced neurohormonal effects. This is consistent with the earlier reports by Abdalaziz et al.[24] Decreased stress on the patient's cardiac muscle following weight loss and better hyperlipidemia status are the two factors that may have contributed to this effect, which is likely complex. Both procedures led to a complete remission of hyperlipidemia, which aligns with the findings of Mahdy et al.[16] and Abdalaziz et al.[24] An increase in lipoprotein lipase activity significantly reduces triglyceride levels when someone loses weight. Simultaneously, they experience a reduction in Apo-lipoprotein C-III levels, a decline in the cholesterol-ester-transfer protein activities, and an elevation in triglyceride-rich lipoprotein catabolism.[25] Additionally, we anticipate that weight loss will lead to a decrease in LDL-C levels, potentially due to the stimulation of LDL receptors.[26] Both procedures cured other complications such as genitourinary, venous, and sleep apnea; thereby patients had an improved quality of life.

Both LOAGB and SASI were performed without major intraoperative complications, with no cases of intraoperative bleeding, bowel injury, or anesthesia-related adverse events. The mean operative time was slightly longer in the SASI group compared to LOAGB (P=0.08), which is consistent with the additional anastomosis required in SASI. This finding was within the usual limits reported in Mahdy T, Emile et al., and Romero RJ et al. studies.[14,20] This could reflect an improvement in our experience-learning curve

Both procedures were performed safely, with no major intraoperative complications or conversions to open surgery. Intraoperative complications were comparable (7.1% in OAGB vs. 8.1% in SASI, p = 1.000), and early postoperative complications were slightly higher in OAGB (9.5% vs. 5.4%, p = 0.679), though not statistically significant.

However, late postoperative complications (>30 days) were more frequent in SASI (16.2%) compared to OAGB (9.5%), particularly regarding biliary reflux, gallstone formation, and nutritional deficiencies. This suggests that while SASI provides superior metabolic benefits, it may require more intensive nutritional monitoring to prevent deficiencies and complications such as protein malnutrition and bile reflux.

The higher rate of cholelithiasis in SASI patients (10.8% vs. 4.8% in OAGB) may not be solely due to the rate of weight loss. Despite faster initial weight loss in OAGB, differences in bile metabolism or dietary factors may explain the elevated incidence in SASI.

All study-recorded problems were mild-to-moderate severity by Clavien-Dindo classification, denoting a favorable safety profile for both procedures. Although, not being statistically significant, the difference between both procedures may be clinically significant within a larger patient population

We assessed the effectiveness of bariatric interventions not only via weight loss but also via their impact on complications, food tolerance, the patient's quality of life, and eating disorder behaviors. In comparison to the preoperative conditions, the postoperative health-related quality of life has improved. Yet, no statistically significant differences between both procedures were found. Postoperative complications may impact the quality of life postoperatively, but the presence of side effects like repeated vomiting, cholelithiasis, and anemia did not hinder the improvement of quality of life.[27]

Although our study demonstrates a significant early postoperative 6 months rise in GLP-1 levels, the long-term sustainability of this response remains unclear. The SASI procedure, by enhancing distal nutrient stimulation, may offer a more prolonged incretin effect compared to LOAGB. This is one of few studies comparing LOAGB and SASI procedures with a specific focus on the GLP-1/HBA1C response. However, long-term follow-up studies are needed to determine whether the observed metabolic advantages persist beyond one year and whether differences in GLP-1 response translate into superior long-term diabetes remission rates.[28-30]

Limitations

Despite these promising findings, our study has limitations. The sample size was relatively small, and long-term follow-up beyond one year is needed to determine whether the metabolic benefits of SASI persist over time compared to LOAGB. Additionally, the lack of continuous GLP-1 measurements beyond 6 months limits our ability to evaluate whether GLP-1 elevation is transient or sustained over time. Future randomized controlled trials with longer follow-up periods are essential to confirm our findings and explore the durability of metabolic improvements.

Conclusions

Both OAGB and SASI are effective bariatric procedures, achieving significant weight loss, glycemic improvement, and comorbidity resolution over 12 months. While weight loss outcomes were comparable, SASI demonstrated a superior GLP-1 response, which correlated with greater HbA1c reduction and higher diabetes remission rates, making it a promising option for patients with poorly controlled diabetes. However, SASI had a higher incidence of late complications, including biliary reflux and nutritional deficiencies, emphasizing the need for careful patient selection and long-term monitoring. In contrast, OAGB had a more favorable safety profile regarding late complications, making it a safer option for patients at higher risk of malnutrition or bile reflux.

These findings highlight the neurohormonal impact of bariatric surgery, demonstrating that GLP-1 elevation plays a key role in metabolic improvements beyond weight loss. Future research should focus on long-term durability of metabolic outcomes and optimizing postoperative care to minimize complications while maximizing benefits.

Abbreviations

LOAGB: laparoscopic one anastomosis gastric bypass.
SASI: Single Anastomosis Sleeve Ileal bypass.
GLP-1: Glucagon-like peptide-1.
DM: Diabetes Miletus.
HTN: Hypertension.
BMI: Body mass index.
EBMIL %: Excess BMI loss percentage.
EWL %: Excess weight loss percentage.
W/H: Waist-to-hip ratio.
HbA1c: Hemoglobin A1c.
GERD: Gastro-esophageal reflux disease.
ECG: Electrocardiogram.
M-A QoLQII: Moorehead-Ardelt Quality of Life Questionnaire II.
SPSS: Statistical Package for Social Sciences.
SD: Standard deviation.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

Availability of data

Data sharing does not apply to this article as no datasets were generated or analyzed during the current study.

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