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ORIGINAL CONTRIBUTIONS

Single-Anastomosis Sleeve Ileal (SASI) Bypass: Hopes and Concerns after a Two-Year Follow-up

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Abstract

Background Single-anastomosis sleeve ileal (SASI) bypass is a simplification of sleeve gastrectomy with transit bipartition. Both share a metabolic foundation through early postprandial ileal brake, and SASI bypass has the advantages of shorter operative time and less incidence of internal herniation. This study evaluates the safety and outcome of SASI bypass with 2-year follow-up.

Methods A retrospective cohort study of all patients who underwent SASI bypass in the period between June 2016 and January 2019. The primary outcome was weight loss and diabetic remission.

Results Three hundred twenty-two patients underwent SASI bypass with a mean age of 37.4 ± 15 years and a mean body mass index of 50.1 ± 7.7 kg/m^2. Thirteen patients (4%) had early major postoperative complications. The 1-year percentage of excess weight loss (%EWL) was 86.9 ± 9.2, and diabetic remission rate was 98.2%. The 2-year %EWL was 96.7 ± 5, and diabetic remission rate was 97.9%. Twenty-six patients had gastroesophageal reflux that improved in 21 (80.7%) patients, remained stationary in 4 (15.4%) patients, and worsened in one patient who required reversal. One patient (0.3%) had severe protein-energy malnutrition and is prepared for reversal. Technical variations had no significant impact on %EWL or diabetic remission.

Conclusion SASI bypass had a promising outcome in terms of 2-year %EWL, diabetic remission, and improvement of preoperative GERD. However, stationary or progressive course of GERD is a substantial possibility. Although the double-outlet for the gastric content allows duodenal access, it may be an obstacle to the standardization of postoperative care. The double-outlet is not a guarantee for absence of malnutrition.

Keywords Single-anastomosis sleeve ileal bypass · SASI bypass · Diabetic remission · Metabolic surgery · Bariatric innovations

Introduction

Obesity is a worldwide preventable pandemic associated with chronic metabolic disorders as type II diabetes mellitus (T2DM), dyslipidemia, and hypertension (HTN) [1]. Bariatric surgery was superior to conservative measures in the management of obesity in terms of outcome and health expenses [2]. Many randomized controlled trials showed the superiority of bariatric surgery over medical treatment in diabetic remission [3]. However, the quest for the ideal bariatric procedure is ongoing since the dawn of bariatric surgery in the 1950s [4].

Santoro IIIB procedure, a simplification of digestive adaptation procedure and duodenal switch procedure, entailed sleeve gastrectomy (SG) and Roux-en-Y ileo-gastrostomy with a common limb length (CLL) of 80 cm (transit bipartition) without duodenal exclusion [5]. This was the first bariatric design with two outlets for the gastric content through the duodenum and the gastro-ileal anastomosis. The procedure maintains easy endoscopic access to the duodenum, and it is technically simpler as it does not involve duodenal division or manual duodeno-ileal anastomosis. Santoro theorized a metabolic, rather than a restrictive or malabsorptive, foundation for the procedure through early postprandial ileal brake [6]. Functional, rather than mechanical, restriction is created by the early passage of the gastric content to the terminal ileum which potentiates the release of terminal ileal hormones, as glucagon-like peptide 1 (GLP-1) and polypeptide YY (PYY),

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leading to decreased gastric emptying and slower intestinal transit [6, 7].

After growing acceptance of one-anastomosis gastric bypass (OAGB), many new techniques were proposed in the last decade in the context of modifying a Roux-en-Y bariatric configuration into a simple loop configuration for the advantages of shorter operative time and less risk of internal herniation (Fig. 1). In this context, Mui et al. reported the first modification of Santoro IIIB procedure into sleeve gastrectomy with loop bipartition in a case report [8]. This was followed by a case series (50 patients) by Mahdy et al. on the procedure with a 1-year follow-up, and the term single anastomosis sleeve ileal (SASI) bypass was coined in this study [9]. Few studies reported the safety and outcome of the procedure, and most of them were by the primary authors. The aim of the present study is to assess the safety and efficacy of SASI bypass.

Patients and Methods

Study Design and Definitions

This is a retrospective cohort study of all patients who underwent SASI bypass in the period between June 2016 and January 2019. Candidates for bariatric surgery were psychologically stable morbidly obese patients within the age limits of (18–65) years. Candidates for SASI bypass were patients convinced that SASI bypass carries the advantages of SG and OAGB and patients who had type II DM and asked for metabolic bariatric procedures other than OAGB and RYGB. The investigational nature of the procedure was explained for all candidates, and it was made clear that the mid-term and long-term follow-up of the procedure was still unknown. All patients signed a written informed consent after a thorough explanation of the expected outcome of surgery with special emphasis on the need for long-term follow-up and lifelong vitamin supplementations. The primary outcome was weight loss and remission of T2DM. Secondary outcomes included postoperative complications, operative time, and resolution of comorbidities other than T2DM.

Morbid obesity was defined as body mass index (BMI) > 40 kg/m^2 or BMI 35–40 kg/m^2 associated with obesity-related comorbidities as T2DM, HTN, dyslipidemia, and obstructive sleep apnea syndrome (OSAS). Weight loss was expressed as a percentage of excess weight loss (%EWL) and percentage of total body weight loss (%TBWL). The recommendations of the American Diabetes Association were adopted for the definition of diagnosis and cure of T2DM [10, 11]. Postoperative complications and remission of obesity-related comorbidities were defined according to the standardized outcome reporting of bariatric surgery [12].

Preoperative Preparation

Patients were evaluated by a multidisciplinary bariatric team constituting of a general physician, psychiatrist, dietician, endocrinologist, anesthesiologist, trained bariatric nurse, and bariatric surgeon. In preparation for surgery, the candidate joined a patient support group and enrolled in a preoperative weight loss program according to the BMI. Pelvi-abdominal ultrasound was performed routinely for preoperative

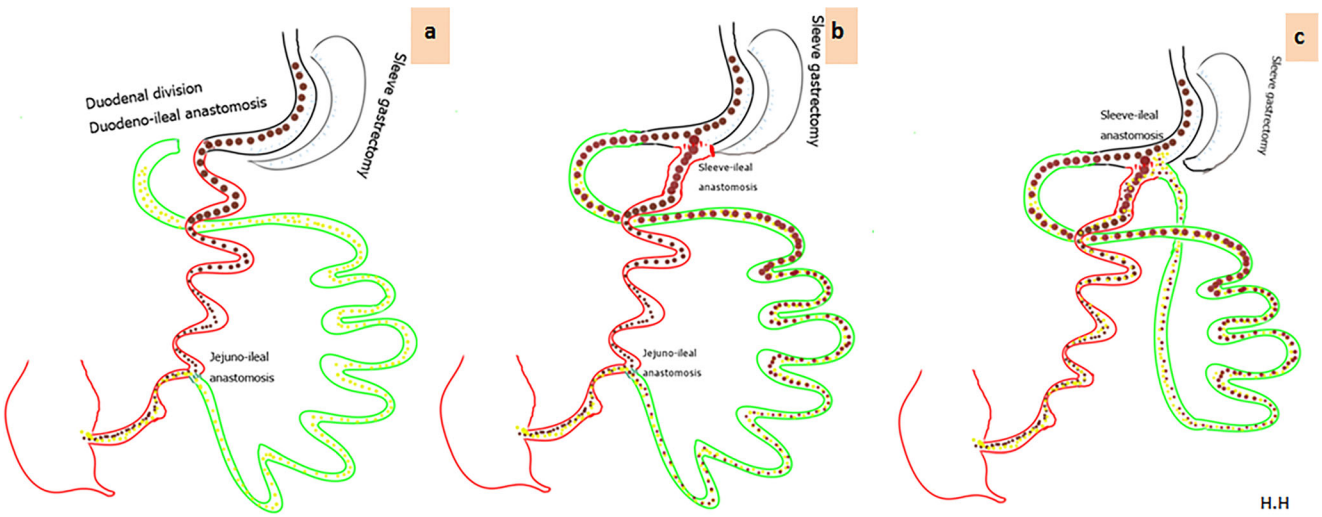

Fig. 1 **a** Biliopancreatic diversion with duodenal switch (BPD/DDS) entailing sleeve gastrectomy, duodenal division, duodeno-ileal anastomosis, and jeuno-ileal anastomosis. **b** Santoro IIIB procedure is different from BPD/DS in the absence of duodenal division and duodenal anastomosis. The procedure consists of sleeve gastrectomy, sleeve-ileal anastomosis, and jeuno-ileal anastomosis. **c** Single anastomosis sleeve ileal (SASI) bypass is different from the Santoro IIIB procedure in the absence of jeuno-ileal anastomosis. The procedure consists of sleeve gastrectomy and simple loop sleeve-ileal anastomosis (brown dots: Pathway of the gastric content. Yellow dots: Pathway of biliopancreatic secretions)

evaluation. Upper endoscopy was performed for patients with upper gastrointestinal symptoms, including heartburn, epigastric pain, vomiting, and regurgitation. Patients with endoscopic evidence of gastroesophageal reflux diseases GERD or hiatus hernia were not offered SG or SASI bypass. Patients with gastrointestinal symptoms were tested for *H. pylori* infection by a rapid urease test. *H. pylori* infection was eradicated by triple therapy administrated for 2 weeks. Patients with mild GERD symptoms with negative endoscopy could have SASI bypass after a thorough explanation of the procedure and the risk of exaggerating reflux symptoms. A prophylactic dose of subcutaneous low molecular weight heparin was routinely administered to all patients based on their weight the night before the operation. Proper thromboembolic prophylaxis was administered for patients with a history of thromboembolic diseases [13]. Patients who had OSAS were prepared by continuous positive airway pressure under the supervision of a pulmonologist. Derangement in metabolic profile was corrected before surgery; however, some patients did not reach complete correction after months of preparation.

Operative Details

The patient was positioned under general anesthesia in semi-Flower's position and the surgeon standing between patient legs. The surgery was performed through a 5-port laparoscopic approach. SG was performed starting 6 cm from the pylorus using a 40-F bougie. Then, the ileocecal valve was identified with the table in the supine position and the surgeon on the left side. The length of the CL was determined according to the total bowel length (TBL). If the TBL was ≤ 6 m, the CLL was 250 cm. The CLL was 300 cm if the TBL was more than 6 m. The CLL was measured along the anti-mesenteric border at a 10-cm interval until 250–300 cm. Again, the surgeon stood between patient legs, and the ileum was brought upwards and anastomosed to the gastric antrum. The anastomosis was performed in a horizontal pattern with the antrum or in a vertical pattern starting from the antrum and parallel to the first staple (Fig. 2). The anastomosis was 3 or 4 cm in diameter and was performed either manually or by a linear stapler (Blue reloads, Echelon Flex™ Endopath® Staplers, Ethicon Endo-Surgery, Johnson and Johnson, USA; or Blue reloads, Endo GIA Ultra Universal Stapler, Medtronic, USA). In the case of the thick gastric wall as in patients with a history of intragastric balloon insertion, we used *Endo* GIA™ purple reloads (OR: Echelon Flex™ GST System, blue reload). In the case of stapled-anastomosis, the aperture to the stapler was closed by polydioxanone or Vicryl 3–0 sutures in two layers. Integrity and patency of the anastomosis were tested by the methylene blue test. Lastly, a drain was placed to the left of the anastomosis and the staple line of the SG using Jackson-Pratt® Round Hemaduct® closed drainage systems with bulb reservoirs (Cardinal Health Inc., Product Code: JP-HUR150, SU130-1305; Dublin, Ohio, USA). The drain was removed after 24 h if the drainage fluid was serous or serosanguinous.

Postoperative Care

Patients were discharged to the intensive care unit or the ward according to the condition. Oral fluid intake was started 6–24 h after surgery according to patient tolerance. Patients were discharged after 48 h unless there was a deviation from the normal postoperative course. Patients were routinely prescribed proton-pump inhibitors (*Omeprazole 40 mg once daily)* for the first month after surgery. Protein supplements were prescribed in the first 2 months after surgery. Calcium, iron, and multivitamins were prescribed daily for the first 6 months and then guided by laboratory investigation. Patients were scheduled for follow-up after 2 weeks and then every 3 months in the first year followed by an outpatient evaluation every 6 months afterward. Patient evaluation on follow-up included clinical examination, assessment of weight loss, evaluation for resolution of comorbidities, and presence of de novo complaints suggestive of GERD or nutritional deficiencies. GERD improvement was defined by the reduction in the frequency of symptoms and the need for antireflux medications.

Statistics

After approval of the local ethical committee, patient data were retrieved from a prospectively maintained bariatric database. The minimum duration of follow-up was 12 months. Statistical analyses were performed using SPSS version 17

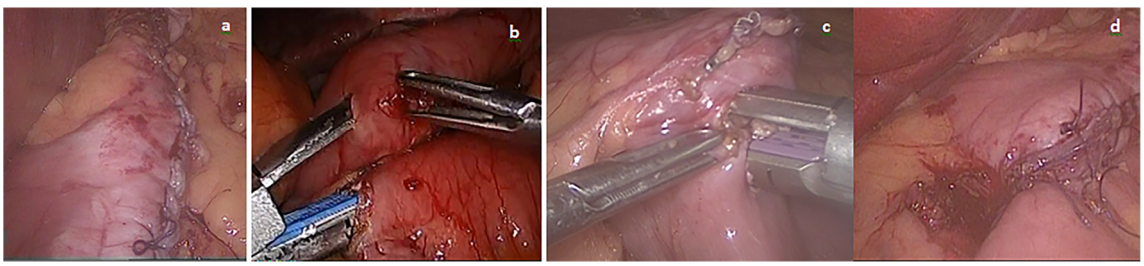

Fig. 2 Technique of single-anastomosis sleeve ileal (SASI) bypass entails **a** sleeve gastrectomy, followed by gastro-ileal anastomosis in **b** vertical pattern or **c** horizontal pattern and the gastroenterostomy is then closed manually **d**

(Chicago, IL). Categorical variables were expressed as group percentages and compared for independent samples using the chi-square test. Continuous data were presented as medians with ranges or means with standard deviation and were compared for independent samples using *T* test or Mann-Whitney test according to data distribution. The strength of the association between variables was further assessed by the Spearman correlation coefficient. *P* value was considered significant at level < 0.05.

Results

During the study period, 322 patients underwent SASI bypass with a mean age of 37.4 ± 15 years and a mean BMI of 50.1 ± 7.7 kg/m^2. One hundred forty-five patients (45%) were super-obese with BMI > 50 kg/m^2, and 39 patients (12.1%) were super-super-obese with BMI > 60 kg/m^2. Patient demographics and preoperative data are summarized in Table 1. All procedures were performed through a laparoscopic approach. No revisional SASI bypass was performed during the study period. Operative details and early postoperative complications are summarized in Table 2. The mean TBL of the study cohort was 6.4 ± 1.01 (5.5–11.3) m. The mean TBL in the CL = 250 group was 5.9 ± 0.17 (5.5–6.5) m., while the mean TBL in the CL = 300 group was 8.4 ± 0.92 (6.5–11.3) m. Intraoperative bleeding from the staple line occurred in 16 (5%) patients and was controlled by suturing. Intraoperative blood transfusion of one unit was required in 6 (1.9%) patients.

Early major postoperative complications occurred in 13 patients (4%). Two patients (0.6%) had an internal hemorrhage and were managed by laparoscopic suturing of the staple line. Hematemesis associated with hemoglobin drop occurred in 10 patients (3%), and upper endoscopy revealed a definite source at the anastomosis in 3 patients who were managed by endoscopic clipping in two patients and adrenaline injection in one patient. No definite source was detected in 7 patients, and the condition was managed by conservative measures, including blood transfusion. There was no anastomotic bleeding in the hand-sewn anastomosis.

Staple line leakage near the angle of His occurred in one patient (0.3%) who presented with symptoms and signs of

Table 1 Preoperative data

Age (years)	37.4 ± 15
Female sex	198 (61.5%)
BMI (kg/m^2)	50.1 ± 7.7
Diabetic state	
None	113 (35.1%)
Prediabetes	98 (30.4%)
Diabetic	111 (34.5%)
Duration of diabetes (years)	5.3 ± 4.2
Patients on insulin therapy	35 (31.5%)
Preoperative FBG (mg/dl)	156.6 ± 26.3
Preoperative HBA1C (%)	8.1 ± 1.4
Other comorbidities	
Hypertension	56 (17.4%)
OSAS	21 (6.5%)
Osteoarthritis	42 (13%)
Dyslipidemia	39 (12.1%)
Hypothyroidism	14 (4.3%)
GERD	26 (8.1%)
Previous surgery	
Upper abdominal surgery	23 (7.1%)
Lower abdominal surgery	47 (14.6%)
Non-abdominal surgery	3 (0.9%)

BMI, body mass index; *DM*, diabetes mellitus; *OSAS*, obstructive sleep apnea syndrome; *GERD*, gastroesophageal reflux disease; *FBG*, fasting blood glucose; *HBA1C*, hemoglobin A1C

Table 2 Operative and early postoperative data

Staple line reinforcement	30 (9.3%)
Anastomotic orientation	
Vertical	70 (21.7%)
Horizontal	252 (78.3%)
Method of anastomosis	
Stapled	310 (96.3%)
Hand-sewn	12 (3.7%)
Anastomotic diameter	
4 cm	266 (82.6%)
3 cm	56 (17.4%)
Common limb length	
250 cm	116 (36%)
300 cm	206 (64%)
Concomitant procedures	
Pelvic adhesiolysis	3 (0.9%)
Cholecystectomy	9 (2.8%)
Ovarian cystectomy	2 (0.6%)
Repair of umbilical hernia	2 (0.6%)
Operative time (minutes)	98.8 ± 16
Time to start oral (hours)	12 (6–24)
Postoperative complications	
Bleeding	12 (3.7%)
Extraluminal bleeding	2 (0.6%)
Intraluminal bleeding	10 (3.1%)
Staple line leakage	1 (0.3%)
Wound infection	7 (2.2%)
Pneumonia	2 (0.6%)
Thromboembolic complications	None
Hospital mortality	None

local abdominal sepsis 1 week after surgery. The patient was managed by laparoscopic drainage and endoscopic stent insertion. One week after stent insertion, downward migration of the stent occurred, and endoscopic repositioning were performed. The stent was extracted after 6 weeks, and complete healing was confirmed by endoscopy, upper contrast study, and clinically on subsequent follow-up.

All patients completed 1-year follow-up, and 204 (63.4%) patients completed 2-year follow-up. Progress of weight loss, gastrointestinal manifestations, and resolution of comorbidities are detailed in Table 3. Gastrointestinal symptoms of diarrhea, steatorrhea, dumping, and constipation responded well to lifestyle modifications and medical treatment. One patient (0.3%) who had a CLL of 250 cm experienced protein-energy malnutrition. The patient presented 8 months after surgery with severe hypoalbuminemia (1.6 g/dl), which improved to 2.5 g/dl after intensive nutritional therapy, and he is prepared for revisional surgery by dismantling of the gastro-ileal anastomosis.

No patient was diagnosed with gastro-ileal anastomotic ulcers during the follow-up period. None of the patients developed de novo GERD symptoms. In this series, four patients with preoperative upper gastrointestinal symptoms were positive for *H. pylori*, and symptomatic relief was achieved after eradication therapy. Twenty-six patients had preoperative GERD symptoms with normal endoscopy and negative tests for *H. pylori* infection. Preoperative GERD ($n = 26$) symptoms improved in 21 (80.7%) patients, remained stationary in 4 (15.4%) patients, and worsened in 1 (3.9%) patient with evidence of severe biliary reflux on upper endoscopy, and he was managed by conversion to Roux-en-Y gastric (RYGB) bypass. Seventeen (5.3%) patients were diagnosed with biliary reflux based on a complaint of recurrent bilious vomiting, and epigastric pain and upper endoscopy revealed excess bile in the gastric lumen. Biliary reflux was managed medically in 16 patients besides surgical revision of the afore-mentioned patient with preoperative GERD. One patient had gastric stenosis below the cardia and was managed successfully by endoscopic balloon dilatation using achalasia balloon. On these late endoscopies, a reduction in the size of the stoma to the efferent limb was noted in 11 patients, and within-average stoma size was noted in 6 patients. Univariate analysis of the impact of different surgical techniques (horizontal vs. vertical anastomosis, 3-cm vs. 4-cm anastomosis, and CLL of 250 cm vs. 300 cm) on the operative and the postoperative outcome is summarized in Table 4. There was no significant association between various techniques and the outcome except for better improvement of HTN with vertical anastomosis ($P = 0.01$).

Table 3 Weight loss, gastrointestinal manifestations, and resolution of comorbidities after SASI bypass

6-month weight loss	
% EWL	58.7 ± 12.2
%TBWL	29.5 ± 5.6
1-year weight loss	
%EWL	86.9 ± 9.2
%TBWL	44.2 ± 7.1
1-year diabetic state	
Improved	2 (1.8%)
Resolved	109 (98.2%)
1-year HTN	
Improved	43 (76.8%)
Resolved	13 (23.2%)
1-year OSAS	
Improved	7 (33.3%)
Resolved	14 (66.7%)
1-year OA	
Improved	8 (19%)
Resolved	34 (81%)
2-year weight loss	
%EWL	96.7 ± 5
%TBWL	49 ± 7.6
2-year diabetic state	
Improved	1 (2.1%)
Resolved	47 (97.9%)
2-year HTN	
Improved	8 (29.6%)
Resolved	19 (70.4%)
2-year OSAS	
Improved	0 (0%)
Resolved	9 (100%)
2-year OA	
Improved	7 (53.8%)
Resolved	6 (46.2%)
Gastrointestinal manifestations	
Dumping syndrome	1 (0.3%)
Steatorrhea	1 (0.3%)
Change in bowel habits	
Diarrhea	14 (4.3%)
Constipation	66 (20.5%)
Cholelithiasis	14 (4.3%)

SASI bypass, single-anastomosis sleeve ileal bypass; *%EWL*, percentage of excess weight loss; *%TBWL*, percentage of total body weight loss; *HTN*, hypertension; *OSAS*, obstructive sleep apnea syndrome; *OA*, osteoarthritis

Discussion

The ideal bariatric procedure should be safe, technically easy, and effective in weight loss and resolution of comorbidities [14]. SASI bypass was developed as a simplification of the Santoro IIIB procedure, and the primary reports regarding safety and efficacy were promising [8, 9, 15–17]. However, available reports by the primary authors reported only a 1-year

Table 4 Impact of various surgical techniques in SASI bypass on the outcome

	Anastomotic orientation			Anastomotic size			Common limb length		
	Horizontal	Vertical	*P* value	3 cm	4 cm	*P* value	250 cm	300 cm	*P* value
Operative time (minutes)	98.8 ± 16.7	98.6 ± 13.5	0.9	95.9 ± 13.4	99.4 ± 16.5	0.1	99.4 ± 16.5	95.9 ± 13.4	0.1
Intraluminal bleeding									
Yes	7 (2.8%)	3 (4.3%)	0.4	0 (0%)	10 (3.8%)	0.2	10 (3.8%)	0 (0%)	0.2
No	245 (97.2%)	67 (95.7%)		56 (100%)	256 (96.2%)		256 (96.2%)	56 (100%)	
Change in bowel habit									
Diarrhea	12 (4.8%)	2 (2.9%)		4 (7.1%)	10 (3.8%)		10 (3.8%)	4 (7.1%)	
Constipation	53 (21%)	13 (18.6%)	0.3	15 (26.8%)	51 (19.2%)	0.4	51 (19.2%)	15 (26.8%)	0.4
6 months %EWL	58.4 ± 12.5	59.8 ± 10.9	0.3	59.4 ± 13	58.5 ± 12	0.5	58.5 ± 12	59.4 ± 13	0.5
6 months %TBWL	29.3 ± 5.7	30 ± 5	0.4	29.9 ± 6.1	29.4 ± 5.5	0.5	29.4 ± 5.5	29.9 ± 6.1	0.5
1 year %EWL	86.5 ± 9.3	88.3 ± 8.7	0.4	85.1 ± 10.3	87.2 ± 8.9	0.2	87.2 ± 8.9	85.1 ± 10.3	0.2
1 year %TBWL	44 ± 7.2	44.8 ± 6.8	0.1	43.1 ± 6.8	44.4 ± 7.2	0.1	44.4 ± 7.2	43.1 ± 6.8	0.1
1-year diabetic state									
Resolution	80 (97.6%)	29 (100%)	1	21 (100%)	88 (97.8%)	1	88 (97.8%)	21 (100%)	1
Improvement	2 (2.4%)	0 (0%)		0 (0%)	2 (2.2%)		2 (2.2%)	0 (0%)	
1-year HTN state									
Resolution	6 (14.6%)	7 (46.7%)	0.01	2 (15.4%)	11 (25.6%)	0.7	11 (25.6%)	2 (15.4%)	0.7
Improvement	35 (85.4%)	8 (53.3%)		11 (84.6%)	32 (74.4%)		32 (74.4%)	11 (84.6%)	

SASI, single-anastomosis sleeve ileal bypass; *%EWL*, percentage of excess weight loss; *%TBWL*, percentage of total body weight loss; *HTN*, hypertension

follow-up, and most of them had a small sample size. The current study reports a 2-year follow-up in a larger bariatric population after the SASI bypass.

The 1-year %EWL in this series was 86.9 ± 9.2, which is comparable with the initial report by Mahdy et al. (90%) [9]. However, a later multi-center study by Mahdy et al. reported a much lower 1-year %EWL (64%) that was explained by wide variation in surgeon expertise and lack of technical standardization [16]. The 2-year %EWL in this series was 96.7 ± 5, which accords with the percentage of excess BMI loss (%EBMIL) after the Santoro IIIB procedure (94.1%) [6]. However, Santoro et al. reported a gradual rebound of lost weight on subsequent years of follow-up with a 3-year %EBMIL of 85.2%, 4-year %EBMIL of 78.5%, and 5-year %EBMIL of 74% [6]. So, although the 2-year %EWL seems optimum in experienced hands, there is a need for long-term follow-up.

All studies are homogenously reporting promising results regarding the efficacy of SASI bypass in remission of T2DM. The reported rate of diabetic remission or improvement after 1 year was (99.3–100%) [9, 15–17]. In this series, the reported 1-year remission rate was (98.2%), and a 2-year remission rate was (97.9%). This is much higher than the diabetic remission rate (86%) after the original Santoro IIIB procedure [6]. Nevertheless, at least a 5-year follow-up is required to confirm the efficacy of bariatric procedures in the resolution of comorbidities [18].

Mahdy et al. reported a diabetic remission rate of 90% 1 month after primary SASI bypass [9]. In revisional SASI bypass after SG in 58 patients, Mahdy et al. reported a 100% diabetic remission rate despite low %EWL (40.9%) [16]. Diabetic remission before or in the absence of adequate weight loss confirms hormonal, rather than restrictive or malabsorptive, mechanisms for remission. Possible hormonal mechanisms include reduced ghrelin hormone due to SG, and increased ileal hormones (GLP-1, PYY) due to early postprandial ileal brake [15, 19, 20]. In a recent prospective randomized study comparing Santoro III B procedure with medical treatment in 20 diabetic patients (BMI 28–35 kg/m^2), there was a significant increase in GLP-1 after 24 months in the surgical group (14,869.2 vs. 5396.3, $P < 0.001$) [7]. More studies of the hormonal basis for diabetic remission after Santoro IIIB and SASI bypass will help better understanding of the bariatric physiology.

The promising outcome of the newly developed procedure that is comparable with other malabsorptive procedures, like OAGB, RYGB, and BPD/DS, can be partially attributed to the demographic criteria of the study population in current reports regarding age and BMI (Mahdy et al., 39.1 ± 14.7 years, 43.2 ± 12.5 kg/m^2; Salama et al., 31.2 years, 43.2 kg/m^2; Vennapusa et al., 40.74 years, 43.48 kg/m^2; Kermansaravi et al., 41.8 years, 44.2 ± 4.3 kg/m^2; our series, 37.4 ± 15 years, 50.1 ± 7.7 kg/m^2) [15–17, 21]. Also, patients who accept new bariatric procedures are usually patients with high motivation

and higher compliance with postoperative instructions. So, the promising results of the SASI bypass can be partially justified by being mostly performed for highly motivated younger patients with a BMI of (40–50 kg/m^2) and a short history of T2DM. Comparative studies between SASI bypass and well-established malabsorptive procedures are required to evaluate the efficacy of the procedure.

SASI bypass is supposed to improve preoperative GERD through the reduction of intra-gastric pressure by the gastro-ileal anastomosis [15]. The multi-center study by Mahdy et al. reported a 92% improvement rate in GERD compared with 80% in this study [16]. The former study reported performing SASI bypass as a rescue procedure to treat severe reflux after SG with no details on the number or outcome in this subgroup [16]. In this series, one patient has progressively worsening intractable GERD symptoms with evidence of severe biliary reflux on upper endoscopy. Symptom relief was achieved by conversion to RYGB. No postoperative de novo GERD was reported in both studies.

The double-outlet for the gastric content was not a guarantee for the absence of severe malnutrition. Vennapusa et al. reported 11 patients (9.7%) with hypoalbuminemia (< 3 g/dl), and one patient (CLL 250 cm) was managed by dismantling of the anastomosis [15]. Kermansaravi et al. revised SASI bypass to SG in 2/24 patients (8.3%) due to excessive weight loss and hypoalbuminemia [17]. In this series, one patient (CLL 250 cm) had severe hypoalbuminemia and is prepared for reversal. Mahdy et al. reported reversal of one patient (2%) due to excessive weight loss in their initial report [9]; however, the reversal rate was not mentioned in the later multi-center study [16]. Preoperative patient counseling regarding the need for long-term follow-up, vitamin supplementation, and frequent assessment by laboratory investigations is important to avoid late presentation with severe malnutrition even if it was a minor possibility.

Anastomotic intraluminal bleeding was the most common cause of major early postoperative complications (10/13, 76.9%) in this series. This is in accordance with the complication pattern after OAGB due to preserved blood supply to the gastric tube along the lesser curvature [22]. Routine intraoperative judicious assessment of hemostasis along the anastomotic line before suturing the gastroenterostomy with selective intraoperative endoscopy is of paramount importance. Staple line leakage from SG near the angle of His occurred in one patient and was successfully managed by endoscopic stenting and laparoscopic drainage with no special considerations for the gastro-ileal anastomosis.

The presence of a double-outlet for the gastric content can be a blessing or a curse for the procedure. Double-outlet provides a credit over malabsorptive procedures by preserving easy endoscopic access to the duodenum and biliary system. On the other hand, the variability and unpredictability of the percentage of the gastric content passing through the gastro-ileal anastomosis and its impact on the gastrointestinal physiology can make it impossible to standardize the postoperative care. In a physical context, the dividing manifold is a closed conduit with multiple outlets [23]. This is the physical equivalent to the bariatric design in the SASI bypass. Fluid distribution through multiple outlets is governed by many factors, including outlet spacing, diameter ratio, pressure, content velocity, density, and frictional forces [23, 24]. This complexity in the determination of flow distribution is doubled in humans where multiple hormonal, behavioral, and neurological factors are added.

In our experience, four findings are raising concerns regarding the role of the gastro-ileal anastomosis in SASI bypass. Change in bowel habits towards constipation is more frequently (20–45%) encountered than diarrhea (2.5–4%), which is more in line with the purely restrictive procedure [15, 16]. Second, the near absence of dumping syndrome (0–0.3%) elicits doubts regarding the fraction of gastric content passing in the anastomosis. Third, there was no significant impact of various anastomotic techniques or CLL on the outcome of the procedure. Lastly, most of the patients who underwent delayed postoperative upper endoscopy had a reduction in the size of inlet to the efferent limb. Innovative techniques to assess individual patient perception of the procedure and the impact of double-outlet on gastrointestinal physiology may be the clue to the standardization of the postoperative care of the procedure.

The limitations of this study include its retrospective nature. However, data were extracted from a prospectively maintained bariatric sheet. Another limitation is the small sample size; however, the current study population is accepted for a recently developed procedure. The study reports a 2-year follow-up which can be considered a medium-term follow-up, but there is a need for long-term follow-up. The last limitation is the absence of a control limb to compare the efficacy of the procedure to another malabsorptive procedure.

In conclusion, SASI bypass showed a promising outcome in terms of 2-year %EWL (96.7 ± 5%) and near-optimal diabetic remission (97.9%). There was a high rate (80%) of improvement of preoperative GERD, but there is a substantial possibility of stationary (15%) or even progressive (4%) course. The double-outlet for the gastric content was not a guarantee for the absence of severe malnutrition. Although it allows easy endoscopic access to the duodenum, it may act as an obstacle to the standardization of postoperative care of the procedure. Long-term follow-up and prospective large-scale studies comparing the procedure to other malabsorptive procedures are required for assessment of the safety and efficacy of SASI bypass.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval The study was approved by the local ethical committee.

Informed Consent Informed consent does not apply.

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