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The outcomes of single anastomosis sleeve jejunal bypass as a treatment for morbid obesity (Two-year follow-up)

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Abstract

Introduction Santoro's operation is a sleeve gastrectomy with transit bipartition. The aim of the procedure is to keep pass to the duodenum to decrease nutritional deficiency and to allow endoscopic management of obstructive jaundice. To be easier, this procedure was rapidly altered to a single anastomosis sleeve ileal bypass (SASI). In this study, we shifted the anastomosis up to the jejunum to evaluate the effect of laparoscopic single anastomosis sleeve jejunal (SASJ) bypass as a treatment for morbid obesity and related comorbidities. In addition, the effect of the SASJ procedure on nutritional deficiency was examined.

Methods In this study, 150 morbidly obese patients underwent SASJ bypass with a biliary limb length of 200–250 cm. All patients were followed up at 1, 3, 6, 12, 18, and 24 months. We evaluated all cases by assessing BMI, complications, nutritional status, and obesity-related comorbidities.

Results The mean age of participants was 30.6 years, and the mean body mass index (BMI) was 44.6 kg/m^2. Of the patients, 35 (23.2%) had type two diabetes and 47 (31.3%) were hypertensive. Postoperative bleeding occurred in two cases (1.3%). One patient developed a gastric leak (0.7%), and five patients developed biliary gastritis (3.3%). One patient (0.7%) developed a pulmonary embolism. The %EWL reached 85% in 1 year. Normalization of blood glucose occurred within 2 months after surgery in all diabetic patients. Hypertension underwent remittance in 89% of hypertensive patients. All patients were gradually weaned from four types of multivitamin regimens to only one multivitamin regimen without apparent nutritional deficiency.

Conclusions Laparoscopic SASJ bypass is an effective, safe, and simple procedure for treating morbid obesity and comorbid conditions with least nutritional deficiency. However, long-term studies are needed.

Keywords SASI · Loop bipatition · Single anastomosids sleeve jejunal bypass · Sleeve jejunal bypass · Sleeve loop bipartition

Obesity is a critical health problem associated with an increased risk of cardiovascular disease, diabetes, and cancers, affecting both the quality of life and life expectancy [1]. The increasing prevalence of obesity and comorbid conditions requires effective treatment and prevention [2]. Previous evidence has demonstrated that bariatric surgery is associated with greater and longer-term weight loss than non-surgical management [3]. Thus, in patients with a body mass index of ≥ 40 or ≥ 35 kg/m^2 with co-morbidities, bariatric surgery is the most effective treatment option that not only promotes weight loss but also improves comorbid conditions. However, like any surgical procedure, several complications can occur. The development of nutritional deficiencies is a complication which may be life-threatening; therefore, bariatric surgery requires careful consideration [1]. The most commonly performed bariatric surgery worldwide is the vertical sleeve gastrectomy (VSG), the Roux-en-Y gastric bypass (RYGB), and the mini-gastric bypass, which has been demonstrated to produce excellent bariatric and metabolic outcomes [4, 5]. Another effective procedure, recently approved by the IFSO, is a one-loop duodenal

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switch or single anastomosis duodenal-ileal bypass with a sleeve procedure (SADI-S) [6].

In addition to these procedures, Santoro et al. has developed a novel procedure: the sleeve gastrectomy with transit bipartition (SG + TB). Long-term data on SG + TB revealed that this procedure increases the stimulation of the distal gut and diminishes the exposure of the proximal part of the small intestine to food [7]. For more simplicity, a single anastomosis sleeve ileal (SASI) bypass was introduced by Mui et al. as a modification of Santorini's operation [8, 9]. Mahdy et al. described the advantages of the SASI procedure over other bariatric procedure based on the following observations: 1) SASI is a simple procedure with a shorter operative time compared to other procedures; 2) it keeps pass to the duodenum so the biliary tree and the whole gut and can be assessed by the endoscope; 3) unlike SADI, DS, and DJB, the duodenum is not divided so there is no risk of duodenal stump leakage, a serious complication with a reported incidence range of 1–6% [10–12]; 4) the tension on the anastomosis is very minimal compared to other techniques; 5) there are no blind loops, excluded segments, or foreign bodies; 6) SASI can be reversed or converted to another procedure [7]. Single anastomosis sleeve jejunal (SASJ) bypass, which is the focus of this study, is a modification of SASI using a shorter biliopancreatic limb length compared to SASI to prevent long-term nutritional complications. The SASJ bypass appears to be safer than the SASI procedure in patients with excessive weight loss and nutritional deficiencies and is simpler due to its improved surgical ergonomics [9]. Our study aimed to evaluate the efficacy of SASJ bypass as a treatment for morbid obesity and comorbid conditions.

Patients and methods

This prospective cohort study included 150 patients and was conducted between April 2016 and September 2019 in the bariatric surgery unit of Minia University. Operations were carried out on all cases before August 2017; thus, the minimum follow-up period was two years. The study received approval from the ethics committee in our Institutional Review Assembly. This research was carried out in cooperation with the novel metabolic surgery guidelines, the principles of the Declaration of Helsinki, and good clinical practices. All patients were informed by written consent of both the technique of the surgery and the possible complications of the study.

Selection of patients

All morbidly obese patients aged greater than 18 and less than 60 years old with a BMI greater than 40 or greater than 35 with comorbidities were eligible to be included in the study. We excluded patients below 18 or over 60 years of age, patients unfit for surgery, patients requiring revisional bariatric surgery, and patients that refused to participate in the study. Patients that refused to participate in the study were offered any other suitable bariatric procedure.

Study outcomes

The primary outcomes included the following: 1) the percentage of excess weight loss (%EWL), which was calculated as follows: [(preoperative weight – follow up weight)/preoperative excess weight] × 100; 2) the percentage of total weight loss (%TWL), which was calculated as follows: [(preoperative weight – follow up weight)/preoperative weight] × 100; 3) the effect of the operation on type two diabetes mellitus (T2DM): complete remission was defined as an HbA1C level < 6% or a fasting plasma glucose level < 100 mg/dl without any medication. A partial improvement was defined as a reduction of at least 1% in the HbA1c level or at least 25% of the fasting plasma glucose level with hypoglycaemia medications [13].

Secondary outcomes included the following:1) remission of hypertension without antihypertensive medication; 2) remission of sleep apnoea syndrome, which was defined as AHI/RDI of less than five off CPAP/BI-PAP on repeat objective testing with polysomnography; 3) remission of hyperlipidaemia, which was defined as a normal lipid profile without medications [7]; 4) nutritional status.

As for any bariatric procedure, all patients had a routine preoperative evaluation including history, examination, and laboratory investigations. If symptomatic GERD was present, an endoscopy was performed. An abdominal ultrasound was routinely carried out to evaluate the state of the liver and to exclude the presence of gallstones. Low-molecular weight heparin was given subcutaneously for all patients 12 h before surgery as a prophylaxis against deep vein thrombosis.

Surgery technique

The patient was placed in the French position in a steep reverse Trendelenburg position with the surgeon standing between the patient's legs. All patients were operated under general anaesthesia with endotracheal intubation. In the classic sleeve gastrectomy, the operation was begun with the separation of the greater omentum from the stomach. The dissection then was continued upward to dissect the short gastric vessels and to clear the left crus from any attachments. Any adhesions between the stomach and pancreas were dissected. The dissection was continued downward till the pyloric ring. A 36-French calibration tube was used as a guide for a proper sleeve. Using a linear cutting stapler, stapling was begun at 6 cm proximal to the pylorus and

continued upward to separate the stomach. The staple line has then overseen using a running proline suture 3/0. We routinely fixed the sleeve to the left crus to prevent pouch migration into the chest and to decrease the reflux. When the duodenojejunal (DJ) junction was identified, a point 200–250 cm from the DJ was measured. The intestinal loop was then brought up to the gastric sleeve without dividing the greater omentum and was fixed with a stay suture to the sleeved stomach at the pyloric ring. A stapled isoperistaltic side-to-side anastomosis was performed using a forty-five linear cutting stapler at the dissected inferior side of the pylorus. The defect of the gastro-jejunal anastomosis was closed with a two-layer running suture, and a methylene blue test was performed to assess for the presence of leaks (Video.1). Early ambulation and clear fluids were started 6 h after surgery. Thrombosis prophylaxis was continued for 2 weeks, and proton pump inhibitors were administrated for 4 months postoperatively.

Follow-up

All patients were seen in the outpatient clinic weekly for 1 month followed by monthly in the first year, every 3 months in the second year, and every 6 months in the third year. Patients were also seen in the clinic if they developed symptoms between their follow-up visits. The minimal follow-up period was 2 years after the SASJ bypass. The patients were evaluated with regard to weight loss and improvement in comorbidities. All patients were continued on a liquid diet for 2 weeks, followed by a soft diet in the next week. Subsequently, patients were put on a high protein, low-calorie diet. Other elements were introduced sequentially under dietitian supervision. The patients were prescribed high-concentration multivitamin supplements (Centrum silver® once daily, Calcitron® once daily, Ferritron® once daily, Neuroton® injection twice weekly, Devarol S® 200000 iu monthly) to be taken regularly for two years then gradually withdrawn, ending with taking only Centrum® in the third year. This nutritional protocol was intended to test the degree of the nutritional deficiency after SASJ even with no supplementation. This nutritional protocol was based on a study of SASI by Salama et al. in which multivitamin administration was stopped at 6 months postoperative [14]. In addition, many studies reported that malnutrition improved after two years even with the more malabsorptive procedure [15]. In our experience with many sleeved patients, we have observed that patients who stopped their vitamin regimens by themselves at 1–2 years postoperative were lost to follow-up; later, when they returned to the clinic with new relative cases, they did not show any signs of malnutrition. Furthermore, when we asked for a routine investigation, no malnutrition was present.

All patients had a complete blood test every three months according to the protocol of our bariatric unit, including liver function, complete blood panel, HBA1c, fasting blood sugar, serum albumin, serum iron, and serum vitamin D. The specific investigations were performed on request according to the patient clinical condition. In addition, any early or delayed complications were recorded.

Statistical analysis

Data were analysed using IBM® SPSS® (version 17.0 for Windows). Data were expressed either as mean ± standard deviation (SD) or by percentages. The appropriate statistical analysis methods were performed using both parametric and non-parametric procedures since a chi-square analysis test was used to compare between categorical/ordinal variables, a student t test was used to compare continuous variables, and a Friedman test was used to compare multiple related variables. p values < 0.05 were considered statistically significant.

Results

Preoperative data and follow-up

This study included 150 morbidly obese patients who underwent a SASJ bypass. All patients completed 2 years of follow-up, with 33 patients (22%) followed for 30 months and 17 patients (11.3%) followed for 36 months. These cases were operated on early in the study. The mean age in this study was 30.6 years, and the mean body mass index (BMI) was 44.6 kg/m^2.

Of the study participants, 35 patients (23.3%) had type two diabetes, 47 (31.3%) were hypertensive, 58 (38.7%) had hyperlipidemia, 19 (12.7%) had sleep apnea, and 15 (10%) had preoperative gastroesophageal reflux disease (GERD) or hiatus hernia managed by crural repair with SASJ bypass (Table 1). In one case, an SASJ was planned but an endoscopy revealed a large hiatus hernia. The laparoscopic exploration revealed a very large hiatus hernia with impossible crural repair. Mesh reinforcement of the crurae and RYGB was carried out in this case, which was excluded from the study.

Complications

Although the complication was not from the outcomes of the study, we intended to register it here as this study is the 1st study on SASJ bypass with 2 years of follow-up. Bleeding occurred in two cases (1.3%). In one case, in which the bleeding was intraluminal due to bleeding from the anastomotic line, the patient presented with hematemesis and

Table 1 Preoperative characteristics of patients

Variables	Value
Age	30.6 ± 7.7
Sex	
Female	107 (71.3%)
Male	43 (28.7%)
Weight in Kg	130 ± 15
Height in meter	1,71 ± 0.08
BMI	44.6 ± 4.8
Diabetes	35 (23.3%)
Hypertension	47 (31.3%)
GERD	15 (10%)
Hyperlipidemia	58 (38.7%)
Sleep apnea	19 (12.7%)

Table 2 The postoperative complications

Variable	Incidence	Grade of complication
Leak	1 (0.7)	Grade III
Bleeding	2 (1.3%)	Grade III
Pulmonary embolism	1 (0.7%)	Grade IV
Biliary gastritis	5 (3.3%)	Grade I
Excessive weight loss	1 (0.7%)	Grade I
Weight regain	1 (0.7%)	Grade I
Diarrhea	2 (1.3%)	Grade I
Total	13 (8.6%)	

melena 10 h postoperative and was managed endoscopically with an adrenaline injection and argon plasma cauterization (APC). In the other case, the bleeding was intra-abdominal. Laparoscopic exploration revealed bleeding from the omental side, which was controlled with cauterization and clipping. One patient (0.7%) developed a gastric leak 10 days postoperative which was managed with endoscopic internal drainage. Five patients developed biliary gastritis (3.3%), which presented with epigastric pain and vigorous bilious vomiting; however, these symptoms had a short duration and improved completely with conservative management. One patient (0.7%) developed a pulmonary embolism and was admitted to the cardiac care unit (CCU) and managed conservatively. Ten patients with heartburn (6.7%), none of which were from patients that had preoperative GERD, were managed conservatively. One case (0.7%) developed excessive weight loss in the first year and improved at the end of the second postoperative year. Five patients were readmitted within 30 days of the operation: one had a leak, one had a mild pulmonary embolism, one had pneumonia, and the last two patients experienced biliary vomiting. One patient (0.7%) had weight regain due to a retained fundus and had a fundectomy performed one year following the first surgery. Three patients (2%) developed diarrhoea within the first two months which was managed conservatively (Table 2). According to Sigstad's scoring system, 4 patients developed some dumping symptoms with scores = < 4, but since they improved over time this was not included in the results [16].

The effect of SASJ on weight loss, comorbidities, and nutritional status

The %EWL reached 85% at one year. Normalization of blood glucose occurred within two months after surgery in all diabetic patients. Hypertension was remitted in 89% of hypertensive patients. Additionally, hyperlipidaemia and sleep apnoea syndrome were improved in all cases. GERD was improved in 87% of patients that had preoperative GERD (Table 3). All patients were gradually weaned from multivitamins in the third postoperative year without apparent nutritional deficiency (Table 4).

Discussion

Many bariatric procedures are now available, making selection of the appropriate procedure difficult. The most commonly performed bariatric surgeries worldwide are the vertical sleeve gastrectomy, the Roux-en-Y gastric bypass, and the mini gastric bypass [4, 5]. Despite this, the sleeve gastrectomy is now the most common bariatric procedure in many centres [17]. However, LSG is less effective in obese patients with very high BMI values, has a high incidence of postoperative GERD, and weight regain is a long-term outcome [18, 19]. LRYGB is the most effective operation for treating morbid obesity, but it is technically challenging and has significant perioperative complications. MGB is easier

Table 3 The effect on weight loss, comorbidities

Variable	Value		
	Preoperative no = 150	Postoperative no = 150	*p* value
FBS	92 ± 15	81 ± 7	< 0.0001
HbA1c	6 ± 1	4.8 ± 0.3	< 0.0001
BMI	44.6 ± 4.8	27 ± 1	< 0.0001
Diabetes	35 (23.3%)	0%	< 0.0001
Hypertension	47 (31.3)	5 (3.3%)	< 0.0001
Hyperlipidemia	58 (38.7%)	0%	< 0.0001
Sleep apnea	19 (12.7)	0%	< 0.0001
GERD	15 (10%)	2 (1.3)	< 0.0001
TWL	51.2 ± 14.8		
EWL	85% ± 11%		
Return to work	9 ± 2		

Table 4 Nutritional effect of SASJ bypass

	Preoperative	6 months post-operative	One-year post-operative	2 years postoperative	*p* value
Hb	12.5 ± 1.1	12 ± 1	12.5 ± 0.8	12.7 ± 0.7	< 0.0001
Iron	89.3 ± 7.6	85.3 ± 5.3	91.1 ± 7	92.6 ± 7	< 0.0001
Albumin	4.3 ± 0.3	4 ± 0.3	4.1 ± 0.2	4.2 ± 0.2	< 0.0001
Vitamin D	32.1 ± 7.3	32.3 ± 6.4	35.1 ± 4.9	35.8 ± 4.6	< 0.0001
Ca	9.8 ± 0.3	9.7 ± 0.4	9.9 ± 0.3	9.9 ± 0.3	< 0.0001

than RYGB and has very good long-term results but is associated with malnutrition and remnant gastric cancer [20–22].

Another important issue with RYGB, MGB, and SADI is that the traditional trans-oral ERCP is not possible due to the altered anatomy. Various techniques have been described to access the biliary tree-like including laparoscopic transcystic common bile duct exploration (LTCE), balloon enteroscopic ERCP, percutaneous transhepatic cholangiography (PTC), laparoscopic transgastric ERCP (LTERCP), laparoscopic choledochoduodeonoscopy and EUS-guided transhepatic ERCP. These procedures are challenging, not able to be completed at all institutions, have high complication rates, reach up to 17%, and have a low success rate (5970%.) [23]. Additionally, previous literature has indicated that the incidence of CBD stones following gastric bypass ranges from 0.4 to 11.5% [24–26]. Additional research has reported that the incidence of gallstone formation after bariatric surgery can range from 10 to 38% [27]. The reported incidence of CBD stones with symptomatic cholelithiasis range spans 315% of cases [28–30]. Thus, we can conclude that CBD stones after bariatric surgery is not a rare occurrence.

Another important issue that favours SASJ bypass is that because the stomach or the duodenum are not bypassed in this procedure, endoscopic or radiological examination is possible and easy to perform. However, a literature search revealed that severe disease can affect the bypassed stomach. In one study, eight patients out of 3000 were found to be bleeding from peptic ulcers in the bypassed stomach. In another study, a perforated peptic ulcer was found in 11 out of 4300 patients. Two patients with gastric cancer in the bypassed stomach have been reported [31]. Thus, in the area with a high prevalence of gastric cancer SASJ bypass may be the manoeuvre of choice due to easy application screening.

SADI-S is an effective bariatric procedure and has been newly accepted by the IFSO [6]. However, since food can only travel one way with complete duodenal exclusion, this procedure carries a risk of severe malnutrition [32]. Duodenal division in SADI carries the risk of duodenal stump leak which may be fatal; the reported incidence of duodenal stump leak after SADI or other procedures associated with duodenal division ranges from 16% [10–12]. Another drawback of SADI is difficult endoscopic access to the duodenum and jejunum. Mahdy et al. indicated that SASI is both restrictive and malabsorptive, promoting metabolic effects. SASI has a very high impact on glycaemic control in diabetic patients, with remission rates reaching up to 100%. It keeps pass to the duodenum so the biliary tree and the whole gut and can be assessed by the endoscope. The tension on the anastomosis is very minimal compared to other techniques. There are no blind loops, excluded segments, or foreign bodies, and the procedure can be reversed or converted to other procedures [7]. While performing SASI before shifting to SASJ, we reported on a patient that became underweight and developed malnutrition. The patient insisted on converting to a sleeve, and since the improved procedure could be performed in about 20 min, it was easy to convert to SASJ bypass. The SASJ bypass is a modification of SASI with a short biliopancreatic limb length. SASJ bypass is therefore efficient and safe to prevent long-term nutritional complications [9]. In this study, the %EWL after two years of follow up was approximately 85%. This was higher than the average %EWL after sleeve gastrectomy (56%) or after RYGB (68%) at one year follow up. The EWL for SADI ranged from 91–95%. However, the reported %EWL after SASI bypass at 12 months postoperatively ranged from 6890% [7, 15, 33, 34].

Of the participants, 23.3% of the patients had type two diabetes. All diabetic patients showed no indications of diabetes at three months postoperative, consistent with the findings of Mahdy et al. on SASI bypass [7]. In addition, this result was similar to the results reported for the duodenal switch (98.9%) [35] and greater than the results reported after the sleeve gastrectomy (7281.6%) [4, 36]. Remission of T2DM after the SASJ bypass was mostly due to the restrictive part of the operation, the sleeve gastrectomy, which caused a decrease in caloric intake. In addition, remission was due to the stimulation of the distal gut by rapid delivery of undigested food through the sleeve jejunal anastomosis and to inhibition of the proximal gut by a small portion of food passing through the duodenum [7].

In this study, SASJ bypass was associated with improvements in other obesity-associated comorbidities. In hypertensive patients, 89% showed remission; however, for SASI, sleeve, RYGB, and MGB the reported remission rates are 64%, 62.5%, 70.3%, and 94%, respectively. In this study, the remission rate for hyperlipidaemia was 100%

compared to 65%, 42%, 62.3%, and 96 for SASI, sleeve, RYGB, and MGB, respectively. Sleep apnoea syndrome was improved in 100% of cases in this study compared to 59%, 45.8%, 44.2%, and 90% for SASI, sleeve, RYGB, and MGB, respectively. GERD improved in 87% of cases in this study, compared to 92%, 25%, 60.4% and 92% for SASI, sleeve, RYGB, and MGB, respectively [33–38]

Regarding nutritional status, despite a slight decrease in the level of serum albumin, Hb, vitamin D, and iron after 6 months compared to preoperative value after SASJ bypass but were still above the lower normal level, improved by the end of the first year, and were further improved after the end of the second year. None of the patients developed protein malabsorption, anaemia, or any other nutritional deficiency. These findings are consistent with the SASI bypass study by Mahdy et al., furthermore demonstrating outcomes that were better than those reported for RYGB, MGB or SADI [15, 20, 34].

The incidence of major complications after SASJ bypass was 8.6%, compared to 8.7% for sleeve gastrectomy, 815% after SADI, and 10% for SASI [4, 10, 34]. However, most of these complications were minor, graded as grade I or II on the Clavien-Dindo scale. The most apparent complication was bilious vomiting, which was managed conservatively without any need for conversion. Bile reflux is a common phenomenon in all procedures performing a single anastomosis between the gastric pouch and the intestine and has even been reported after RYGB [39, 40].

Limitations of the study

This study used a cohort, not a controlled trial. In spite of this, it is the first study with this number of patients and 2 years of follow-up. However, the number of patients included is somewhat small, and the duration of follow-up is short. Consequently, another long-term study is needed. In addition, endoscopy should be performed routinely as follow-up in the protocol of the study, which was not done.

Conclusion

Laparoscopic SASJ bypass is an effective, safe, and simple procedure for treating morbid obesity and comorbid conditions with least nutritional deficiency. However, long-term studies are needed.

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Compliance with ethical standards

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