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# Laparoscopic Single Anastomosis Duodeno-ileal Bypass-Sleeve Gastrectomy versus Laparoscopic Sleeve Gastrectomy Regarding Hypoalbuminaemia and Lower Limb Edema

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***Authors' contributions***

*This work was carried out in collaboration among all authors. Author MSA designed the study, performed the statistical analysis and wrote the protocol. Author MAN wrote the first draft of the manuscript. Author AZG managed the analyses of the study. Author MAK managed the literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

**Background:** In a trial to modify the effective biliopancreatic diversion BPD-DS operation- the same way Rutledge modified RYGB by creating one loop end-to-side anastomosis – and to preserve its principles, the single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S) was first introduced in 2007 by Sánchez-Pernaute and Torres as they did Sleeve gastrectomy followed by 1-loop duodenoileostomy, with 250 cm between anastomosis and ileocecal valve. Anastomosis performed in antecolic and isoperistaltic manne

**Purpose:** It is to assess postoperative hypoalbuminaemia and lower limb edema in the two procedures.

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**Patients and Methods:** The interventions were led at Beni-suef University Hospital between January 2018 and December2019, after the patients fitted both the inclusions and exclusions criteria. This study consisted of 36 patients which were randomized into 2 groups.
**Group (A)**: 18 patients assigned for Single Anastomosis Duodeno-ileal bypass – Sleeve Gastrectomy [SADI-S].
**Group (B):** 18 patients assigned for Sleeve Gastrectomy.
**Results:** Mean albumin level at 12 months after surgery was 3.1 g/dl ± 0.35 for SADI-S patients and was 3.83 g/dl ± 0.34 for sleeve gastrectomy patients. There is a statistically significant difference between both groups.
**Conclusion:** SADI-S/OADS is worse than LSG regarding post operative hypoalbuminaemia leading to more lower limb edema.

*Keywords: Hypoalbuminaemia; bowel syndrome; anastomosis duodeno-ileal bypass.*

## 1. INTRODUCTION

The possible way of hypoalbuminemia can be portal pressure increasing which lead to decrease of small bowel absorptive power and progression to malnutrition and hypoalbuminemia [1]. Hypoalbuminemia usually improve after good nutritional support of high-protein diet [2], Decrease of body weight can be achieved after Biliopancreatic diversion, but there is a chance of malnutrition and diarrhea. This chance may be minimized by keeping the pyloric with duodenal switch. Loop duodenal switch (Single anastomosis duodeno-ileal bypass with sleeve gastrectomy=SADI-S) is hybrid operation including moderate food restriction with moderate malabsorption for treatment of high BMI [3]. It is considered a simplified version of the original duodenal switch operation in which after the sleeve gastrectomy, the duodenum is anastomosed in end to side, ante colic and isoperistaltic way to the selected ileal loop with a length of 2 meters from ileocacal valve [4]. SADI-S compared with DS cancel the Roux-en-Y gastric bypass by fashioning an omega loop, and because of the intact pylorus, bile diversion is not needed as the natural barrier remains in place. Keeping of the pylorus provides control of solid stool emptying, reducing the chances of dumping syndrome and assisting in the maintenance of a physiologically based rate of gastric emptying [5].

SADI-S benefits over DS included reduction of the operative risk by eliminating one anastomosis with potentially similar weight loss and health benefits [6].

## 2. PATIENTS AND METHODS

The participant patients were randomized according to computer generated numeric table.

- **Group (A)**: 18 patients assigned for Single Anastomosis Duodeno-ileal bypass – Sleeve Gastrectomy [SADI-S].
- **Group (B):** 18 patients assigned for Sleeve Gastrectomy.

### 2.1 Study Sample

This cohort study consisted of 36 patients which were divided into 2 groups. Patients were enrolled in the study after giving written informed consent**.**

- **Group (A)**: 18 patients assigned for Single Anastomosis Duodeno-ileal bypass – Sleeve Gastrectomy [SADI-S].
- **Group (B):** 18 patients assigned for Sleeve Gastrectomy.

### 2.2 Inclusion Criteria

1. Patients who had BMIs of 40 $Kg/m^2$ or more, or between 35 $Kg/m^2$ and 40 $Kg/m^2$ with obesity related comorbidities that could be improved if they lose weight.
2. Age (18-65) years old.
3. Patients were generally fit for anesthesia and surgery.

### 2.3 Exclusion Criteria

1. Previous gastric or duodenal surgery.
2. Endocrine disorders excluding diabetes mellitus.
3. Psychiatric illness.
4. Recent diagnosis of malignancy.
5. Heavy smokers and alcoholics.

The study was approved from the institutional ethical committee prior to start with a written consent from every patient.

## 2.4 Operative Details

### 2.4.1 Laparoscopic sleeve gastrectomy group surgical technique

1. Positioning: Patients were placed in supine, legs spread (French position), in a steep Fowler (reverse Trendelenburg) position, and the table was slightly tilted right side down for an adequate visualization of the gastroesophageal (GE) junction. The patient was secured to the table. Additionally, above knee elastic stockings was employed to prevent venous thromboembolism.
2. Pneumoperitoneum was created by direct Veress needle at Palmer's point.
3. A 15 mmHg CO2 abdominal pressure was set for all the procedure with 5-6 trocars set up. The first trocar (10-12 mm) was placed 2-3 cm to the left of the midline 15-18 cm caudal from the xiphoid for the placement of a 10 mm/30 degrees lens.
   Both sides of the camera 5- 10 cm away at the same line were placed two 12 mm trocars for both working hands of the surgeon.
   The assistant placed a 5 trocar lateral in the left side of the patient (anterior axillary line) 2-3 cm from the last costal bone.
   Another 5/10 mm trocar was placed at the xiphoid to liver retraction.
4. A 10-mm, 30° scope is used. The left lobe of the liver is retracted to expose the entire GE junction and the lesser curve.
5. The procedure started by cutting the small branches of the gastroepiploic arcade and opening the lesser sac. Then, dissection was carried out along the greater curve, staying very close to it, dividing the branches of both gastroepiploic arteries, until short gastric vessels were divided using an advanced bipolar cutting device or the ultrasonic scalpel. The assistant retracted the omentum laterally during the maneuver and kept repositioning the instrument superiorly to improve exposure of the vessels and avoid bleeding. The remainder of the gastrocolic ligament (without gastroepiploic vessels transection) was severed distally up to 2 cm proximal to the pylorus. The objective of cutting the omentum right by the edge of the greater curve is to minimize the amount of fat attached to the stomach, to make its extraction from the abdomen easier at the end of the operation. The stomach was then lifted to expose its posterior aspect, and all lesser sac attachments of the stomach were freed. This allowed the appropriate positioning of the mechanical suture.
6. The gastrophrenic ligament was divided and the angle of Hiss was exposed to determine the presence of a hiatal hernia, adding the full exposure of the left crus to complete the dissection.
7. Stomach division started 4 cm proximal to the pylorus, to preserve a part of the gastric emptying mechanism of the antrum. Prior to the creation of the sleeve, the anesthetist introduced a 36-Fr bougie to guide the stapling and maintain an adequate lumen of the gastric sleeve. The bougie was placed prior to stapling, guiding it to reach the pylorus, and positioned close to the lesser curve. Care was taken not to divide the stomach too close to the incisura angularis to avoid kinking or stenosis at this level. Green (4.8 mm) stapler cartridge was used for the first two firings and blue for the rest. In any case, all of them were 60 mm in length.
8. Dividing fundus as close as the GE junction as possible, without actually compromising the esophagus 0.5 cm away from the GE junction.
9. Additionally, the perigastric fat was mobilized, permitting better identification of the esophagogastric junction.
10. The anesthetist removed the bougie under direct vision to check the final shape of the sleeve. The stomach was removed through one of the 12-mm ports. The integrity of the staple line was tested with the instillation of 50–100 ml of methylene blue in saline solution. Drain was inserted at the operative bed.

### 2.4.2 Laparoscopic single anastomosis duodeno-ileal bypass–sleeve gastrectomy group

For the sleeve gastrectomy part of the procedure (with the operating table under reverse - trendlenburg position and the surgeon positioned between the legs of the patient):

11. Devascularization of the greater curvature of the stomach with a Harmonic scalpel™ or a Bipolar Ligasure device™
12. The stomach was then tubularized over a suitable sized oral bougie with linear

staplers ,commencing 5-6 cm proximal to the pylorus

Then, For the Single Anastomosis Duodeno-ileal bypass part:

I. The dissection of the greater curvature of the stomach was prolonged through the first portion of the duodenum down to the gastroduodenalartery.
II. The first part of duodenum was divided with a linear blue cartridge stapler, then the table was changed to the horizontal position and the surgeon moved to the left-hand side of the patient.
III. The ileocecal valve was identified and 250 cm was measured upwards.
IV. The selected ileal loop was ascended ante-colically without division of the greater omentum, and stapled iso-peristaltic end-to-side duodeno-ileal anastomosis was completed using a 35 mm blue cartridge.

## 3. RESULTS

### 3.1 Albumine

Mean albumin level at 12 months after surgery was 3.1 g/dl ± 0.35 for SADI-S patients and was 3.83 g/dl ± 0.34 for sleeve gastrectomy patients. There is a statistically significant difference between both groups.

Mixed ANOVA (repeated measures) show significant difference across the time points, P≤0.001. Also there is was significant difference between the two groups in S. Albumin level, P≤0.001. There was significant interaction (Bonferroni comparison Test) between the groups and time. Following interaction there was drop of S. Albumin level from baseline preoperative levels and different Serum Albumin measures at 6, 12 months in the SADI group and significant decrease of S. Albumin between preoperative levels and 3and 6 months follow up level at the sleeve gastrectomy group in SADI-S group.

Four SADI-S patients required readmissions for nutritional support and correction of hypoalbuminemia by parentral nutrition.

One of these patients, a 32-year old woman, had lost her scalp and eyebrow hair at 5 months after surgery.

Another one, a 28-year old woman who required readmission four times for correction of resistant hypoalbuminemia in spite of her compliance for healthy food and supplements.

In addition to the significant hypoalbuminemia in OADS/SADI-S patients, associated resistant lower limb edema was reported in 72.2% of the cases.

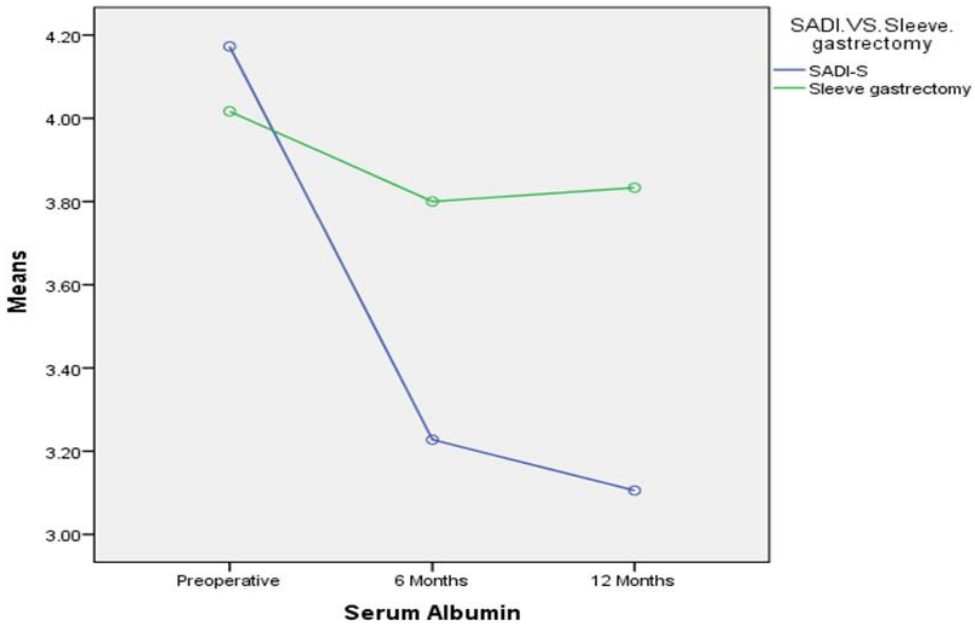


**Fig. 1. S. Albumin across 3 time points between both groups**

**Table 1. Postoperative lower limb edema in both groups**

| Parameter | SAD – S group | Sleeve group | Test of Significance | P - value |
|---|---|---|---|---|
| LL odema | 13 (72,2% ) | 4 (22,2% ) | Likelihood Chi square ($c^2$) test $\chi 2(1, N= 36) = 9.46$ | 0.002 |

## 4. DISCUSSION

Sanchez-Pernaute et al. [7] first introduced SADI-S aiming of simplifying the duodenal switch procedure. The goal of this operation was to decrease the number of intestinal anastomoses, postoperative leaks, obstructions or anastomotic strictures, operative time and anesthetic-related complications. They noticed an excellent weight loss and comorbidities decrease with few complications at three years of follow-up [8]. Primarily the efferent loop length of 200 cm, but lengthened it to 250 cm due to risk of albumin decrease and increased malabsorption risk [9]. No significant difference in weight reduction and comorbidity cure between the two different efferent loop length, and almost 100% of their patients maintained more than 99% of % EWL [10] surgical treatments for high BMI have also grown in frequency and may increase pre-existing vitamin and mineral deficiencies or produce new ones, depending on food intake, adherence to recommended post-operative support and degree of malabsorption associated with the bariatric intervention. Much of the recent data on nutritional deficits in obese persons are from studies of adults undergoing pre-operative evaluations for bariatric procedures, which indicate that baseline nutritional deficiencies are not negligible in extremely obese patients [11].

In our study, mean albumin level at 12 months after surgery was 3.15 g/dl ± 0.35 for SADI-S patients and was 3.83 g/dl ± 0.34 for LSG patients. There is a statistically significant difference between both groups.

In addition to the significant hypoalbuminemia in OADS/SADI-S patients, associated resistant lower limb edema was reported in 76.5% of the cases.

Four OADS/SADI-S patients required readmissions for nutritional support and correction of hypoalbuminemia by parentral nutrition.

One of these patients, a 32-year old woman, had lost the hair of her eyebrows, eyelashes and of her whole body at 5 months after surgery.

Another one, a 28-year old woman who required readmission four times for correction of resistant hypoalbuminemia in spite of compliance for healthy food and supplements.

It is noteworthy that hypoalbuminemia was resistant and parenteral nutrition caused only temporary improvement of the laboratory and the clinical settings.

However, Shoar et al., 2018 reported protein malnutrition in up to 34% of OADS/SADI-S patients [12]. Sanchez-Pernuate et al., 2010 reported that mean albumin concentration was 4.0 g/dl (2.9–4.8) with 24% of patients are under normal limits, however; Four (8%) patients have presented with clinical hypoalbuminemia. All cases happened between the sixth and 12th postoperative months. Hypoalbuminemia was related to severe diarrhea in one case, intra-abdominal infection (subphrenic abscess) in another patient, and recognized reduced food intake in the other two. It is noteworthy that hypoalbuminemia affected 5% of the patients in the second postoperative year and 0% in the third year which suggests that intestinal adaptation may correct the short bowel syndrome encountered in the first year [13]. Also, Nelson et al., 2016 reported that three patients had hypoproteinemia and hypoalbuminemia, however; did not complain of clinical symptoms [14].

Mitzman et al., 2016 reported 1.7% incidence rate (n= 2) of hypoalbuminemia in a total of 123 patients who had been retrospectively reviewed. One of them was due to low nutritional intake. The second patient had a mid-gastric sleeve stricture during the data analysis which led to dysphagia and decreased intake. The patient has been dilated, and her lab results are now normal [15].

In contrary, Lin et al., 2019 stated that only 1.2% of patient who had LSG suffered from hypoalbuminemia [16].

The hypoalbuminemia incidence rate in our OADS/SADI-S patients is higher than the reported in the literature, this may be explained by

1. The tighter sleeve part which was performed may led to more restriction and consequently malnutrition.
2. The common limb length of 250 cm may be still short.
3. The high incidence of diarrhea in our OADS/SADI-S cases.
4. Most cases are secondary to non-compliance with the prescribed diet, which must include a minimal intake of 90 g of protein.
5. Inability to achieve the required multivitamin intake due to the low socioeconomic state.

## 5. CONCLUSION

SADI-S/OADS is more worse than LSG regarding post operative hypoalbuminaemia leading to more lower limb edema.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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