Effect of Laparoscopic Sleeve Gastrectomy versus Laparoscopic Single Anastomosis Sleeve Ileal Bypass (SASI) on Serum Iron

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Introduction: Nutritional deficiencies are usually associated with bariatric surgery. Iron metabolism is usually affected following bariatric surgery.

Aim of work: Is to determine and compare the effect of laparoscopic sleeve gastrectomy (LSG) versus laparoscopic single anastomosis sleeve ileal bypass (SASI) on Iron Profile.

Patients and methods: The study included 74 patients equally divided into two equal groups. Group A (n=37) underwent LSG while Group B (n=37) underwent SASI. Follow-up was designed for the serum iron profile for 6 and 12 months.

Results: There was a statistically significant decrease in EWL% in SASI Group more than LSG Group (p=0.001*). There was a statistically significant drop in the Iron profile components' levels in SASI Group after 1,6 and 12 months compared with the corresponding baseline levels with non significant changes in the LSG group.

Conclusion: Both LSG and SASI are effective in the treatment of obesity however LSG has minimal effect on the iron profile in comparison with SASI procedure so adherent follow up for the Iron profile is mandatory.

Key words: LSG, SASI, iron profile, anemia.

Introduction

Over the previous three decades, there has been a significant increase in the prevalence of obesity. The most common bariatric procedures performed globally are sleeve gastrectomy (SG) and Roux-en-Y gastric bypass (Exclusion from the gastrointestinal tract).[1,2] Iron deficiency, with or without anemia, is common in obese individuals and frequently follows each bariatric surgery procedure.[3] However, these procedures necessitate continued medical attention as well as dietary and vitamin supplementation. Additionally, these might result in serious metabolic abnormalities and are frequently accompanied by vomiting and dysphagia due to anatomical restrictions.[4,5]

Iron insufficiency in obesity is mostly explained by menorrhagia, decreased iron absorption, and low-grade inflammation linked to obesity.[6–8] Bariatric surgery should address the cause of inflammation and restore iron availability by removing excess adipose tissue. However, preoperative iron status typically influences postoperative iron insufficiency, particularly in women.[9] Iron intake within duodenal enterocytes is directly impacted by the possible reasons of this iron deficiency anemia, which include the postoperative inflammatory stimulation itself or a decrease in nutrient absorption. Remarkably, compared to the Roux-en-Y gastric bypass, the SG appears to cause less disruption of the iron balance because the intestinal duodenum is intact.[10,11]

Because of its ease of use, superior comorbidity resolution rates, and exceptional short-term weight loss results, SG has become more well-known as a practical and safe therapy throughout the last ten years.[12,13]

An innovative metabolic and bariatric procedure, the SASI approach is based on Santoro's operation, which includes sleeve gastrectomy and gastroileal loop anastomosis. By bypassing most of the food and allowing it to pass straight into the ileum, this technique maintains the natural food channel, allowing only a small amount of the meal to be absorbed. This results in the desired metabolic effect with a minimal risk of postoperative nutritional issues and permits thorough endoscopic visualization of the biliary system.[14,15]

SASI has gained recognition as a novel and straightforward surgical technique that can get around some of the previously listed limitations, most notably malabsorption, because it doesn't rely on the omission of any digestive system components and doesn't interfere with essential digestive functions. Nevertheless, these surgical techniques have a number of disadvantages that could lead to diarrhea and malabsorption.[16]

This study's objective is to ascertain and present how laparoscopic SG and laparoscopic SASI affect serum iron levels.

Patients and methods

Study design and subjects

The current study was conducted at the general surgery department, Benha university throughout the time from July 2021 till July 2024 including at least 1 year follow-up.

The current study included 74 morbidly obese patients with BMI > 40 kg/m2, Exclusion criteria included patients with renal failure, liver cell failure and Pulmonary dysfunction. Patients who refused to

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be included in the study were also excluded.

Randomization was done using Random Allocation Software 1.0, 2011.

Eligible patients were randomly allocated into one of two equal groups

Group A (n=37) underwent LSG while Group B (n=37) underwent SASI.

For all included patients, complete history taking and physical examination and investigations were done.

Procedure

Group A (LSG): (Fig. 1)

Conventional LSG was performed using A 5 port technique. After insufflation of the Abdomen and insertion of the ports , Dissection of the greater omentum was done stating 5 cm from the pylorus till complete mobilization of the fundus. After that, linear staplers were used to resect the stomach. The staple line were tested using methylene blue for leakage.

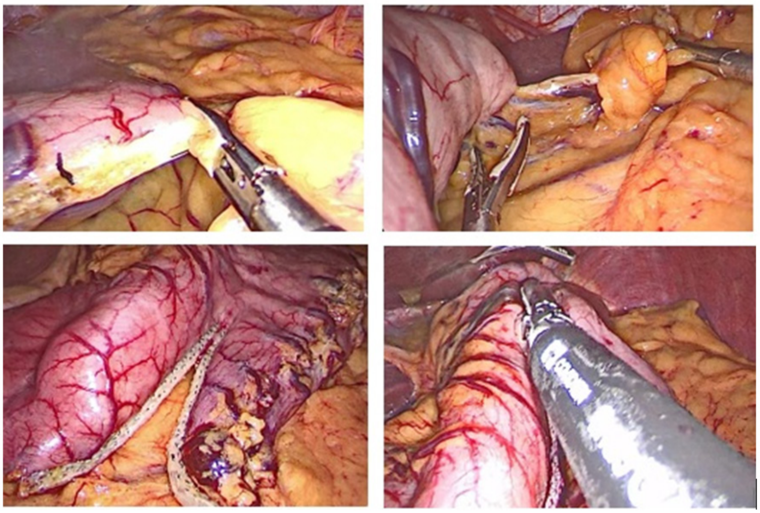

Fig 1: LSG.

Group B (SASI): (Fig. 2)

After the LSD was performed, the patient was put in the Trendelenburg position, The transverse mesocolon of the patient was drawn back towards the head, and a measurement of 250 cm was taken of the small intestine from the ileocecal junction. The posterior wall of the area between the antrum and the stomach body was then used to accomplish an antecolic side-to-side gastro-jejunostomy using a 45-mm linear stapler. The gastroenterostomy staple was sealed using Vicryl 2/0 stitch. The leak test was done using Methylene blue.

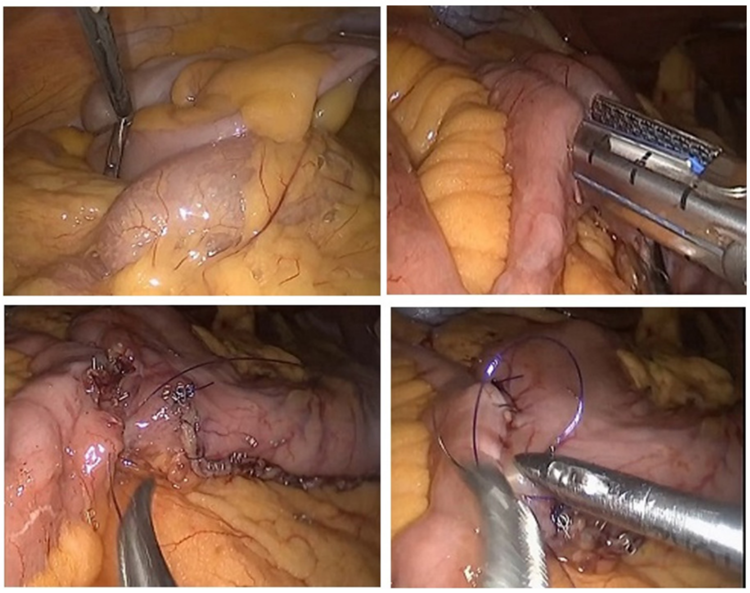

Fig 2: SASI operation.

Starting four weeks after surgery, ferrous fumarate (210 mg) once daily to prevent the -ve impact on the iron profile.

Evaluation and follow-up

Follow-up was designed for1, 6 and 12 months in both groups the serum hemoglobin, serum ferritin as well as EWL%.

Outcomes

The primary research objective was the successful bariatric procedures with minimal nutritional deficiencies.

The secondary outcome was proper estimation and comparison of EWL% in both groups

Statistical analysis

Based on the incidence of 10% loss in follow-up and nutritional inadequacies, the sample size was determined. Using G-power 3.1 software (Universities, Dusseldorf, Germany), a sample size of 74 was taken into consideration with a power of 80%, a P value of 0.05, and an effect size of 0.7.

IBM Corp., Armonk, New York, USA, supplied SPSS, version 25, for the statistical analysis. The student t-test was used for quantitative characteristics that were reported using mean and SD. The χ2 test was used for qualitative indicators that were expressed as frequency with percentage. P-values were considered significant if they were less than 0.05.

Results

74 morbidly obese patients were randomly allocated into two equal groups, Group A (n=37) who underwent LSG while group B (n=37) under went SASI procedure. The mean age was 35.12±6.72.

And 33.92± 4.17years in groups A and B respectively. No significant difference between both groups as regards the base line values of Iron profile **(Table 1).**

Table 2 Demonstrated that there was statistically significant decrease in the mean BMI and EWL% within both groups after 1, 6 and 12 months follow-up with significant decrease in both BMI and EWL% in patients underwent SASI.

As regards the iron profile, a statistically significant decrease in Hb%, serum Iron, serum Ferritin, transferrin saturation and total iron binding capacity in group B, and no significant changes were reported in group A after 1,6,12 Months in comparison with the corresponding baseline levels **(Tables 3,4).**

Table 1: Sociodemographic data and Baseline BMI, Iron profile

Variable		**Group A LSG N =37**	**Group B SASI N=37**	**P value**
Age	**Mean ±SD**	35.12±6.72	33.92± 4.17	0.147
Sex				
Female	N (%)	25 (67.6%)	26 (70.3 %)	0.21
Male		12 (32.3%)	11 (29.7%)	0.19
Baseline BMI	Mean ±SD	46.2± 4.6	44.9± 4.8	0.34
Baseline Hb N=12-16gm/dl [4,17].	Mean ±SD	12.45±2.12	13.1±2.42	0.57
Baseline Serum Iron N=60-170mic/d[4,17].	Mean ±SD	92.3±13.4	96.6±12.4	0.12
Baseline Serum Ferritin N=30-250ng/ml [4,17].	Mean ±SD	122.3±31.7	131.3±28.4	0.24
Baseline Serum transferrin Saturation N=15-50% [4,17].	Mean ±SD	29.6±4.56	28.6±5.6	0.41
Baseline Total iron binding capacity N=250-450mic/dl [4,17].	Mean ±SD	303.7±19.5	311.4±18.9	0.29

Table 2: Pair wise comparison within and in between Groups As regarding BMI and EWL% at 1,6,12 months

Variable	Group	Baseline	6 months	12 months	Baseline Vs 6month	Baseline Vs 12month	6month Vs 12month
BMI (kg/m2) Mean ± SD	LSG Group	46.2± 4.6	35.8± 3.4	28.4±4.7	<0.001*	<0.001*	<0.001*
	SASI Group	44.9± 4.8	31.7±3.3	25.3 ± 2.6	<0.001*	<0.001*	<0.001*
	P value	0.34	0.016*	0.021*			
%EWL Mean ± SD	LSG Group		45.45± 3.9 %	79.5±4.3%			<0.001*
	SASI Group		61.9 ±4.8	93.8± 3.76			<0.001*
	P value		<0.001*	<0.001*			

Table 3: Comparison between the two groups regarding, Iron profile, Vit B12, Folate, Calcium, Vit D3, and parathormone at 1,6,12 months follow up

Variable		Follow up	Group A LSG N =37	Group B SASI N=37	P value
Hb	Mean ±SD	I month follow up	11.5±2.6	11.9± 2.3	0.12
		6 months follow up	11.3 ±2.2	11.4± 2.2	0.09
		12 months follow up	10.9 ±1.1	10.8± 1.7	0.14
Serum Iron	Mean ±SD	I month follow up	88.8± 9.5	89.1± 8.8	0.074
		6 months follow up	93.1±5.2	85.3± 8.1	0.062
		12 months follow up	93.9± 6.9	83.1±4.9	0.056
Serum Ferritin	Mean ±SD	I month follow up	115.6±21.9	115.3±26.2	0.098
		6 months follow up	111.12±19.8	108.9± 23.9	0.082
		12 months follow up	106.4± 22.4	99.2±17.8	0.063
Serum transferrin Saturation	Mean ±SD	I month follow up	28.4±2.6	26.9±1.8	0.064
		6 months follow up	29.8± 2.1	26.19±1.7	0.047*
		12 months follow up	29.3±2.3	24.97±1.9	0.023*
Total iron binding capacity	Mean ±SD	I month follow up	300.6±16.4	302.4±13.7	0.068
		6 months follow up	297.2±15.2	296.3±11.9	0.091
		12 months follow up	295.3±15.6	292.5± 12.3	0.16

Table 4: Mean difference and 95% confidence interval and pairwise comparisons values of the Iron Profile in both groups at 1,6,12 months follow up

		Group A MD (95%CI)	P value	Group B MD (95%CI)	P value
Hb	Baseline vs post 1 M	0.95 (0.48- 1.43)	0.082	1.2 (0.6-1.8)	0.01*
	Baseline vs post 6 M	1.15 (0.58- 1.73)	0.39	1.7 (0.85-2.55)	0.01*
	Baseline vs post 12 M	1.55 (0.78-2.33)	0.053	2.3 (1.15-3.45)	0.01*
	Post 1 M vs post 6 M	0.2 (0.1-0.3)	0.18	0.5 (0.25-0.75)	0.06
	Post 1 M vs post 12 M	0.6 (0.3-0.9)	0.078	1.1 (0.55-1.65)	0.026*
	Post 6 M vs post 24M	0.4 (0.2-0.6)	0.072	0.6(0.3-0.9)	0.82
Serum Iron	Baseline vs post 1 M	3.5 (1.75-5.25)	0.092	6.7 (3.35-10.05)	0.01*
	Baseline vs post 6 M	-0.8 (-0.4 - -1.2)	0.17	11.3 (5.65-16.95)	0.01*
	Baseline vs post 12 M	-1.6 (-8- -2.4)	0.14	13.5 (6.75-20.25)	0.01*
	Post 1 M vs post 6 M	-4.3 (-2.13- -6.43)	0.084	3.8 (1.9- 5.7)	0.38
	Post 1 M vs post 12 M	-5.1(-2.55- -7.65)	0.062	6 (3-9)	0.41
	Post 6 M vs post 24M	-0.8 (-0.4 - -1.2)	0.11	2.2 (1.1 -3.3)	0.28
Serum Ferritin	Baseline vs post 1 M	6.7 (3.35 -10.05)	0.067	16 (8-24)	0.015*
	Baseline vs post 6 M	11.2 (5.6 -16.8)	0.47	22.4 (11.2-33.6)	0.01*
	Baseline vs post 12 M	15.9 (7.95 -23.85)	0.052	32.1 (16.05-48.15)	0.01*
	Post 1 M vs post 6 M	4.5 (2.25-6.75)	0.07	6.4 (3.2-9.6)	0.058
	Post 1 M vs post 12 M	9.2(4.6-13.8)	0.065	16.1(8.05-24.15)	0.01*
	Post 6 M vs post 24M	4.7 (2.35 -7.05)	0.24	9.7 (4.85-14.55)	0.3
Serum transferrin Saturation	Baseline vs post 1 M	1.2 (0.6-1.8)	0.16	1.7(0.85-2.55)	0.01*
	Baseline vs post 6 M	-0.2 (-1- -0.3)	0.23	2.4 (1.2-3.6)	0.01*
	Baseline vs post 12 M	0.3 (0.15- 0.45)	0.13	3.6 (1.8-5.4)	0.01*
	Post 1 M vs post 6 M	-1.4 (-0.7- -2.1)	0.19	0.7 (0.35-1.05)	0.008*
	Post 1 M vs post 12 M	-0.9 (-0.45- -1.35)	0.28	1.9 (0.95-2.85)	0.012*
	Post 6 M vs post 24M	0.5 (0.25-0.75)	0.14	1.2 (0.6-1.8)	0.84
Total iron binding capacity	Baseline vs post 1 M	3.1 (1.55-4.65)	0.19	9.2 (4.6-13.8)	0.01*
	Baseline vs post 6 M	6.5 (3.25-9.75)	0.28	15.1 (7.55-22.65)	0.01*
	Baseline vs post 12 M	8.4 (4.2-12.6)	0.26	18.9 (9.45-28.35)	0.01*
	Post 1 M vs post 6 M	3.4 (1.7-5.1)	0.129	6.1 (3.05-9.15)	0.07
	Post 1 M vs post 12 M	5.3 (2.65-7.95)	0.178	9.9 (4.95-14.85)	0.016*
	Post 6 M vs post 24M	1.9 (0.95-2.95)	0.61	3.8 (1.9-5.7)	0.62

Discussion

One of the widespread problems in the world that is drastically altering conventional lifestyles and increasing the risk of sickness and mortality is obesity.[18] It is widely accepted that bariatric surgery is the best way to address obesity. Bariatric treatments can be divided into three categories based on the method utilized to lose weight: mixed, restrictive, or malabsorptive. LSG is more sought after these days because of its simpler operation technique and fewer complications.[19] SASI emerged as a mixed method that preserves the natural food channel, allowing only a small portion of the meal to be absorbed while the majority of the food is bypassed and goes directly into the ileum.[14,15]

According to numerous studies, one of the most frequent and dangerous long-term side effects of bariatric surgery is vitamin and nutrient deficiencies brought on by structural alterations in the gastrointestinal tract's mechanisms of absorption.[20]

The duodenum and proximal jejunum absorb iron primarily, and the peptide hormone hepcidin controls this process. Hepcidin prevents iron from being transported from enterocytes into the bloodstream by blocking ferroportin transporters on the enterocytes' basolateral membrane. Furthermore, hepcidin prevents macrophages from reusing iron, which is essential for preserving iron homeostasis.[21] Iron-deficiency anemia and hypoferremia can arise from the poor absorption and reutilization of iron caused by inflammation-induced elevation of hepcidin synthesis in obesity.

Chronic PPI medication decreases iron conversion from Fe+3 to Fe+2, and gastritis is typically linked to obesity. Hepcidin is also upregulated as a result of inflammation linked to obesity.[22]

The current study showed that both groups experienced a significant drop in their BMI and EWL% throughout the 12-month follow-up matching the results of Several studies.[4,12]

Iron deficiency anemia is the most frequent anemia in patients after BS. According to certain research, up to 17% of people may develop this anemia following surgery.[23] When diagnosing anemia, a drop in serum ferritin is a more precise indicator than a drop in serum iron. According to studies, up to 30% of patients see a drop in serum ferritin five years following BS.[24]

The iron profile, which included the Hb percentage, serum ferritin, serum iron, serum transferrin saturation, and total iron binding capacity, was routinely tracked for a year after surgery in both groups. Saif et al.[18] found no significant difference in ferritin, iron, or total iron binding capacity (TIBC) following laparoscopic sleeve gastrectomy (LSG) matching the results of the current study where no significant change in serum Hb%, serum ferritin, serum iron or total iron binding capacity after a year and this is explained by the anatomical facts that the duodenum's absorption plays a major role in iron management, which is maintained in LSG. Reduced stomach capacity, however, results in less parietal cell mass, which in turn reduces the generation of hydrochloric acid (HCl). Through two methods, gastric acids play a critical role in iron absorption. First, by denaturing proteins, HCl aids in the release of iron that is bound to proteins. Second, ferric ions from dietary iron sources are reduced to the absorbable ferrous form by HCl.[25] And if the patient is committed to taking the necessary multivitamin supplement, this effect of surgery on iron absorption can be readily avoided.

However, Group B experienced a statistically significant decrease in Hb%, serum ferritin, and serum iron at 1, 6, and 12 months, respectively. This was consistent with findings from Mokhber S et al.[26] and Gowanlock Z et al.[27] This can be explained by the fact that the proximal small bowel is skipped, which means that the ingested iron cannot interact with the gastric acid produced in the bypassed stomach for a sufficient amount of time.[28] Due to adherent post-operative iron supplementation, none of the patients in both groups experienced severe anemia.

Conclusion

The results of this study confirmed the effective role of LSG and SASI in treatment of obesity however it can be important evidence that LSG has minimal effect on the iron profile in comparison with SASI procedure so adherent follow up for the Iron profile is mandatory

Recommendations: Nutritional supplementation for Iron is highly recommended following Both LSG and SASI.

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