The Egyptian Journal of Hospital Medicine (January 2024) Vol. 94, Page 390-399

The Role of Single Anastomosis Duodeno-Ileal Bypass with Sleeve Gastrectomy in Treatment of Type-2-Diabetes Mellitus with Morbid Obesity in Comparison with Mini-Gastric-Bypass

Mohamed E. Zayed, Mohamed M. Abd El-Wahab, Gamal E. Saleh, Mohamed H. Eid *, Ahmed Khairy Allam
Department of General Surgery, Faculty of Medicine, Benha University
***Corresponding Author:** Mohamed H. Eid,email: mostafa.sa.madboly@gmail.com,mobile:+201554464636

ABSTRACT

Background: The surge in obesity globally has paralleled an alarming rise in type 2 diabetes mellitus (T2DM), prompting a search for effective treatment modalities. Bariatric surgery, evolving as a viable intervention for obesity-associated T2DM, encompasses various procedures like the Single Anastomosis Duodeno-Ileal Bypass with Sleeve Gastrectomy (SADI-S) and the Mini-Gastric Bypass (MGB). **This study aimed to** compare the efficacy of SADI-S versus MGB in managing T2DM in obese patients.

Methods: This study was conducted at Banha University Hospitals between September 2021 and September 2022. 50 obese patients with T2DM were enrolled and split equally into SADI-S and MGB groups. Preoperative assessments included comprehensive clinical, laboratory, and radiological evaluations, delineated inclusion and exclusion criteria. Patients underwent meticulous preoperative preparation and received detailed postoperative care, including staged diet regimens and follow-up assessments.

Results: There was statistically significant difference between groups according to treatment, in Triglycerides and cholesterol after 3, 6, and 12 months.

Conclusion: Surgical treatment of T2DM is gaining increasing attention due to the significant influence that weight loss procedures have on glucose metabolism. Carefully selected patients with metabolic syndrome may undergo metabolic surgery without risk. A therapeutic focus is necessary for individuals at high risk due to the heightened susceptibility to type 2 diabetes and cardiovascular disease. According to the findings of our research, SADIS and MGB exhibit comparable efficacy in managing hypertension, diabetes mellitus, and hyperlipidemia.

Keywords: Single Anastomosis Duodeno-Ileal Bypass with Sleeve Gastrectomy; Type-2-Diabetes Mellitus; Morbid Obesity; Mini-Gastric-Bypass

INTRODUCTION

Obesity arises from a combination of inadequate energy expenditure and subsequent energy storage, which culminate in weight gain. In recent decades, it has emerged as a significant healthcare concern in both developed and developing nations [1].

The body mass index (BMI) of an obese person is at least 30 kg/m^2, while those whose BMI is between 25 and 30 are considered overweight. The incidence of obesity and overweight has increased by over twofold since 1980, according to the WHO. As a result, there are now over 2.1 billion people worldwide with a BMI of 25 or higher. There exists a correlation between obesity and a heightened susceptibility to developing musculoskeletal disorders (including osteoarthritis), cardiovascular diseases, premature mortality, and hypertension. The relationship between BMI and postprandial and fasting insulin levels is firmly established as being generally proportional. There is an analogous relationship between BMI and the extent of insulin resistance. The elevation in insulin levels linked to increasing BMI is essential to counteract insulin resistance and sustain normal blood glucose levels [1].

Diabetes is diagnosed in less than 25 percent of the 2.1 billion individuals who are overweight or obese. The incidence of T2D has risen steadily in recent decades, which is commonly attributed to a rise in the proportion of overweight people worldwide [1]. Recently, T2D has evolved into a worldwide pandemic; it is a chronic metabolic disorder characterised by multiple factors and affecting numerous organs. The disease in question is widely recognised and largely attributed to the sedentary lifestyle and the ongoing obesity epidemic. It is also becoming more prevalent on a global scale [2,3]. Weight management and support for healthy lifestyles are central to public health initiatives aimed at averting type 2 diabetes [2]. T2DM constitutes at least 90% of all cases of diabetes and is the most prevalent form [4].

Bariatric surgery is defined as gastrointestinal surgery performed to assist patients who are morbidly obese in losing weight. It affords the greatest practical opportunity for the resolution or improvement of co-morbidities and sustained weight loss for the majority of these patients, including those with diabetes mellitus. During the early 1980s, surgeons observed that a considerable number of type 2 diabetes patients who had undergone gastric bypass surgery to address morbid obesity had achieved a full remission of their condition [1, 2]. Currently, metabolic surgery is characterized as any procedure that reroutes the food passage through the gastrointestinal tract in an effort to alleviate diabetes through a mechanism unrelated to

Received: 02/08/2023
Accepted: 01/10/2023

weight loss. For this reason, bariatric surgery has emerged as a potentially efficacious therapeutic alternative for diabetes [2].

Dr. Robert Rutledge, an American, initially devised the Mini Gastric Bypass (MGB) technique in 1997. This modification was made to the conventional Billroth II procedure. MGB entails constructing a long, slender tube along the right border of the stomach, which has the leaser curvature. An approximately 180-centimeter loop of the small intestine is raised and connected to this tube at the beginning of the intestine (ligament of Treitz) [3].

Scopinaro [4] first described bilio-pancreatic diversion, when severely obese patients required an alternative to jejunoileal bypass. Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S) is an innovative bariatric procedure that operates on the bilio-pancreatic diversion principles. The rationale behind the development of a novel technique or the alteration of an established one was to make the process easier, reduce the likelihood of complications, and preserve or, if feasible, enhance the results of the original operation [5]. The benefits of SADI-S include a single anastomosis, reduced incidence of enteric hernias and protein malnutrition, and effective remission of diabetic complications, particularly type 2 diabetes mellitus (T2DM) [6].

We aimed to assess the effectiveness of Mini-Gastric Bypass versus Sleeve Gastrectomy versus SADI in the management of T2DM among obese patients.

PATIENTS AND METHODS

This a prospective study included 50 patients with obesity and type 2 diabetes and were operated with the same surgical team at Benha University Hospitals.

Inclusion criteria were patients who were willing to provide informed consent and adhere to the prescribed evaluation and treatment plan: they must be between the ages of 18 and 60, male or female, had a BMI greater than 30 kg/m, not abuse alcohol or substances, and have one of the following conditions: metabolic syndrome with obesity (BMI greater than 30), diabetes mellitus (HbAlC > 6.5), and hyperlipidemia (TGs (Triglycerides) greater than 150 mg/dl and T. Cholesterol >200 mg/dl; HDL < 40 mg/dL).

Exclusion Criteria were individuals who have endocrine abnormalities, such as having Cushing syndrome or hypothyroidism, being under the age of 18 or over the age of 60, undergoing major upper abdominal surgery, having previously undergone bariatric operations, having severe cardiovascular or restrictive respiratory diseases, a significant abdominal ventral hernia, or suffering from a major psychiatric illness, were not suitable candidates for insufflation.

Patients were subjected to preoperative assessment comprised the following: age and gender, a history of weight loss attempts exceeding two years, full medical history with special notes, clinical assessment, prior laparotomy with detailed dietary history, gastrointestinal surgery, eating habits, weight loss trials, associated comorbidities, psychological status, and clinical examination including body mass index (BMI).

Full laboratory investigations including liver function tests (Serum albumin / SGOT / SGPT), complete blood picture, lipid profile (HDL / LDL / cholesterol / triglyceride), kidney function tests (Creatinine / urea), hemoglobin A1C for diabetic, thyroid profile (TSH / T4, free T3), and serum cortisol morning and evening, and pulmonary function test.

Radiological imaging including pelvi-abdominal ultrasonography, plain X-ray chest, echocardiography and duplex.

Upper GIT endoscopy: Each patient was routinely thoroughly evaluated by a multidisciplinary team (psychologist and surgeon, nutritionist, endocrinologist).

Ethical considerations:

This study was done between September 2021 to September 2022 at Benha University Hospitals, Benha, Egypt (Approval Code: MD13.12.2022).

Consent for surgery: A fully informed consent was taken from the patients discussing with them the operative procedure and the possible postoperative and intraoperative complications.

Procedure: All patients were admitted to the hospital one day before the surgery regarding anesthetics. Anesthesia by muscle relaxant-infused general endotracheal route was administered to all patients.

1. **SADIS:**

Creating Pneumoperitoneum: For establishing pneumoperitoneum, the closed method utilising a Veress needle was considered the preferred approach, and it was inserted at Palmer's point, which is located two fingers' breadth below the subcostal margin in the left midclavicular line. Within the range of 15 to 20 mm, the intra-abdominal pressure was maintained.

Placement of Liver Retractor: A rapid diagnostic laparoscopy was performed to detect any inadvertent injuries. A Nathanson hook liver retractor was inserted via a 5 mm incision in the sub-xiphoid region to lift the left lobe of the liver if the examination revealed no abnormalities.

Sleeve Dissection: The procedure began by employing a harmonic scalpel to devascularize the greater curvature of the stomach. Following this, a 36 French oral bougie was utilised to tubularize the stomach, while a linear gold cartridge was inserted six cm proximal to the pylorus. Through the initial segment of the duodenum and down to the gastroduodenal artery, a prolonged dissection of the greater curvature occurred. A critical stage of the SADI procedure involved performing a thorough dissection of the duodenum, which included the identification of the pyloric artery that originates from the gastroduodenal artery.

Duodenal Dissection and Section: Surgical procedures included the following meticulous steps: Once the duodenum had been dissected to a depth of 2 cm beyond the pylorus, the pancreas was meticulously separated from the gastroduodenal artery and pancreatoduodenal groove. Although the peritoneum was being opened at the duodenal margin, precautions were taken to safeguard the right gastric artery. Utilizing a linear blue cartridge stapler, the duodenum was divided while vascularization to the lesser curvature, including the supraduodenal artery and the right gastric artery, was maintained. The initial stage commenced with the surgeon positioned between the patient's legs while the table was inclined in an anti-Trendelenburg position; subsequently, the surgeon shifted to the patient's left side and resumed the procedure in the horizontal table position. A hand-stitched sutures or 30-mm linear stapler were utilized to define an isoperistaltic end-to-side duodeno-ileal anastomosis subsequent to the identification of the ileocecal junction and the cranial lifting of 250 cm of ileum to reach the duodenal stump. By sealing off the outlet with methylene blue, one could examine the shape, volume, and potential leaks of the anastomosis.

2. **MGB**

Following anesthesia induction, the patient was positioned in reverse Trendelenburg with arms abducted, and legs split (French position) firmly secured to prevent movement throughout repositioning. Sterilization and draping occurred between the nipple line and upper thigh. The camera operator was positioned to the right, the assistant to the left, and the surgeon between the patient's legs. A Veress needle was utilised to administer CO_2 insufflation in the left subcostal region. To achieve this, a 10-12 mm trocar was inserted under direct vision at a location 3 cm left of midline and 15 cm below the xiphoid. A 30-degree angled laparoscope was used and entering the peritoneal cavity was achieved through the port, followed by placement of 5-12 mm and 5 mm trocar ports in specific positions for various instruments and retraction purposes.

Postoperative care: Post-surgery, patients underwent a strict fasting period until a third-day gastrograffin contrast study. Prophylactic measures were performed, including anticoagulant therapy, subcutaneous heparin, and elastic stockings, aimed at preventing pulmonary embolism. Intravenous antibiotics and continuous analgesia managed infection and pain, while proton pump inhibitors prevented stress ulcers. Nasogastric tubes, if present, were commonly removed by the second day post-contrast study, marking the transition to clear oral fluids. A gradual, staged diet, overseen by nutritionists, guided patients from fluids to protein-rich liquids and finally to soft, low-calorie, and low-sugar, low-fat meals over months. Discharge typically occurred on the third postoperative day, emphasizing a structured diet plan for the gradual reintroduction of solid foods.

Postoperative diet regimen: Patients were advised a structured eating routine: 4-6 small meals daily, each the size of a measuring cup, to be consumed slowly with small, well-chewed bites. Red meat was discouraged, replaced by daily vitamin/mineral supplements. Hydration with low-calorie drinks between meals (6-8 cups/day) was recommended, while raw fruits and veggies were to be avoided. A gradual transition to a low-fat solid diet involved meticulous chewing, limited water intake with meals, incremental food additions, delayed introduction of bread, and daily iron and zinc supplements. Discharge criteria included mobility, tolerance of liquid diet, controlled pain with oral analgesics, and absence of complications. Overeating post-surgery leads to stomach discomfort; lifelong multivitamin intake compensates for reduced nutrient absorption, necessitated by the limited food intake capacity. Physicians recommended a protein-rich, low-fat diet due to this reduced intake capability.

Follow-up: weekly for a month post-hospital discharge, then at 6 weeks, followed by assessments at 3, 6, 9, and 12 months, shifting to annual check-ups. Monitoring encompassed BMI, FBS, HbA1c, adjustments or cessation of anti-hypertensive medications, and anti-diabetic, lipid profiles, and blood pressure. Postoperative issues like hernia, food intolerance, or reflux were documented, while the surgery's success rate was evaluated based on specific criteria after the 12-month mark. This comprehensive monitoring aimed to track patients' health, medication adjustments, and surgical outcomes over time.

Outcomes Assessment: The study meticulously tracked patient progress post-surgery by assessing weight loss through BMI changes at various intervals and recording complications both during and after surgery. Diabetes control was monitored via HbA1c and fasting blood sugar measurements, coupled with adjustments in anti-diabetic medication. Blood pressure checks and alterations in anti-hypertensive drugs monitored hypertension control, while lipid profiles tracked hyperlipidemia control, all at specified intervals. Preoperative patient characteristics, including age, sex, family history of diabetes, medication type, and diabetes duration, were documented, categorizing diabetes control based on HbA1c levels and prior complications. Glucose metabolism statuses were delineated using FBS levels per American Diabetes

Association guidelines, with a target HbA1c level set by the American College of Endocrinology for diabetes control.

Statistical analysis

The collected data were analyzed utilizing the Statistical Package for the Social Sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). The means and standard deviations were used to represent quantitative data (SD). Frequency and percentage were utilized to represent qualitative data. A paired t-test for significance on samples was utilized to compare two means. A one-way analysis of variance (ANOVA) was utilized when more than two means were being compared. A chi-square (X^2) test of significance was employed to compare the proportions of the two qualitative parameters. The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, P-value >0.05 was deemed to be insignificant.

RESULTS

It is a retrospective cohort study which was done between September 2021 -September 2022 and one year follow up following this time frame, at Benha University Hospitals, Benha, Egypt. This study included 50 obese patients with type 2 DM; 25 patients treated by MGB and 25 other treated by SADIS operation.

No statistically significant difference was present between groups according to demographic data or preoperative data but only statistically significant difference was seen according to TG (**Table 1**).

Table 1: Comparison between groups according to demographic data and preoperative parameters.

	Demographic Data	Group I (N=25)	Group II (N=25)	p-value
Age (yeas)	Mean±SD	38.12±8.44	37.60±7.63	0.820
	Range	25-55	25-55	
Sex	Female	16 (64.0%)	18 (72.0%)	0.544
	Male	9 (36.0%)	7 (28.0%)	
Preoperative				
Anthropometric measurements				
Weight.	Mean±SD	136.36±21.85	136.40±19.82	0.995
	Range	95-170	95-170	
Height.	Mean±SD	166.36±10.92	163.80±10.36	0.400
	Range	145-188	150-183	
BMI [wt/(ht)^2]	Mean±SD	49.36±7.00	50.73±7.59	0.511
	Range	36.7-66	39-66.6	
Co-morbidities				
DM				
HbA1c	Mean±SD	10.92±1.19	11.36±1.15	0.190
	Range	9-13	9-13	
FBS	Mean±SD	176.80±15.47	182.00±17.80	0.276
	Range	150-210	150-210	
HOMA	Mean±SD	8.20±1.19	7.64±1.25	0.112
	Range	6-10	6-10	
Treatment	Insulin	12 (48.0%)	8 (32.0%)	0.248
	`Oral	13 (52.0%)	17 (68.0%)	
	HTN	12 (48.0%)	11 (44.0%)	0.777
Lipid Profile				
TG	Mean±SD	193.40±32.01	216.80±35.91	0.019*
	Range	140-300	120-280	
Cholesterol	Mean±SD	232.00±18.93	226.40±17.29	0.280
	Range	190-260	200-260	
LDL	Mean±SD	166.40±12.21	168.00±13.84	0.667
	Range	140-190	140-190	
HDL	Mean±SD	47.04±4.83	47.52±6.04	0.758
	Range	41-57	41-65	

Paired t-test; #x2: Chi-square test, BMI: Body Mass Index, DM: Diabetes Mellites, FBS: Fasting blood sugar, HOMA: Homeostatic model assessment, HTN: Hypertension, TG: Triglycerides, LDL: Low-density lipoproteins HDL: Heigh density lipoproteins. *: Significant

A statistically significant difference was observed among the groups in terms of treatment, regarding TG, and cholesterol after three months, 6 months and 12 months (**Table 2**).

Table 2: Comparison between groups according to all parameters of postoperative (3 months, 6 months, and 12 months).

	Postoperative (3 months)	Group I (N=25)	Group II (N=25)	p-value
Anthropometric measurements				
Weight.	Mean±SD	111.68±14.57	112.84±14.94	0.782
	Range	88-140	82-145	
Co-morbidities				
DM				
HbA1c	Mean±SD	8.80±0.91	8.60±1.00	0.464
	Range	7-11	7-10	
FBS	Mean±SD	138.40±10.28	139.96±13.51	0.648
	Range	120-160	120-170	
HOMA	Mean±SD	7.20±0.96	6.96±1.02	0.395
	Range	6-9-	5-8	
TTT	Insulin	3 (12.0%)	5 (20.0%)	0.032*
	Oral	8 (32.0%)	15 (60.0%)	
	Stopped	14 (56%)	5 (20.0%)	
	HTN	9 (36.0%)	11 (44.0%)	0.564
Laboratory				
TG	Mean±SD	157.60±20.47	176.00±18.71	0.002*
	Range	120-200	150-230	
Cholesterol	Mean±SD	215.20±14.75	205.60±15.83	0.031*
	Range	180-240	170-240	
LDL	Mean±SD	156.40±12.21	154.00±14.14	0.524
	Range	130-180	130-180	
HDL	Mean±SD	49.76±4.47	50.76±4.62	0.44
	Range	44-59	44-62	
Serum ferritin	Mean±SD	82.80±32.73	79.60±32.59	0.731
	Range	30-150	20-120	
Wt.	Mean±SD	100.04±13.20	101.88±14.11	0.636
	Range	80-125	75-130	
Co-morbidities				
DM				
HbA1c	Mean±SD	7.86±0.93	7.90±1.37	0.904
	Range	6-10	6-11	
FBS	Mean±SD	128.80±13.33	127.20±17.20	0.715
	Range	100-150	100-160	
HOMA	Mean±SD	6.20±0.91	5.88±1.05	0.257
	Range	5-8	4-7	
TTT	**Insulin**	0 (0.0%)	0 (0.0%)	0.024*
	Oral	16 (64.0%)	8 (32.0%)	
	Stopped	9 (36.0%)	17 (68.0%)	
	HTN	4 (16.0%)	5 (20.0%)	0.713
Lipid profile				
TG	Mean±SD	145.92±23.67	166.60±17.72	0.001**
	Range	90-190	140-220	
Cholesterol	Mean±SD	200.00±13.54	189.20±11.15	0.003*
	Range	170-230	160-210	
LDL	Mean±SD	132.80±13.08	131.20±13.01	0.666
	Range	100-150	110-160	

	Postoperative (3 months)	Group I (N=25)	Group II (N=25)	p-value
HDL	Mean±SD	53.20±4.50	54.88±4.35	0.186
	Range	47-62	50-65	
Serum ferritin	Mean±SD	71.32±35.22	61.16±37.01	0.325
	Range	8-145	5-110	
Weight.	Mean±SD	79.80±13.97	0.649	
	Range	50-105		
Co-morbidities				
DM				
HbA1c	Mean±SD	6.06±0.87	0.878	
	Range	5-8		
FBS	Mean±SD	101.00±21.41	0.31	
	Range	70-140		
HOMA	Mean±SD	2.36±1.29	1	
	Range	1-5		
TTT	**Insulin**	0 (0%)		
	Oral	2 (8.0%)	0.221	
	Stopped	23 (92.0%)		
	HTN	3 (12.0%)	0.684	
Lipid Profile				
TG	Mean±SD	120.40±13.61	0.008*	
	Range	95-145		
Cholesterol	Mean±SD	185.60±9.61	<0.001**	
	Range	160-200		
LDL	Mean±SD	114.40±8.21	0.472	
	Range	100-130		
HDL	Mean±SD	56.00±11.08	0.197	
	Range	6-64		
Serum ferritin	Mean±SD	77.60±35.94	0.293	
	Range	10-150		

DM: Diabetes Mellites, FBS: Fasting blood sugar, HOMA: Homeostatic model assessment, HTN: Hypertension, TTT: tilt table test, TG: Triglycerides, LDL: Low-density lipoproteins HDL: Heigh density lipoproteins, HbA1c: Hemoglobin A1c *: Significant, **: Highly Significant.

(T-test is not suitable to compare Postoperative (3 months) Serum ferritin, Postoperative (6 months) Serum ferritin, Postoperative (12 months) FBS and Postoperative (12 months) Serum ferritin in table 2 because samples are not normally distributed. Use another suitable test e.g., Mann-Whitney test)

Weight measurements in group I revealed a notable and statistically significant difference over the periods (**Figure 1**).

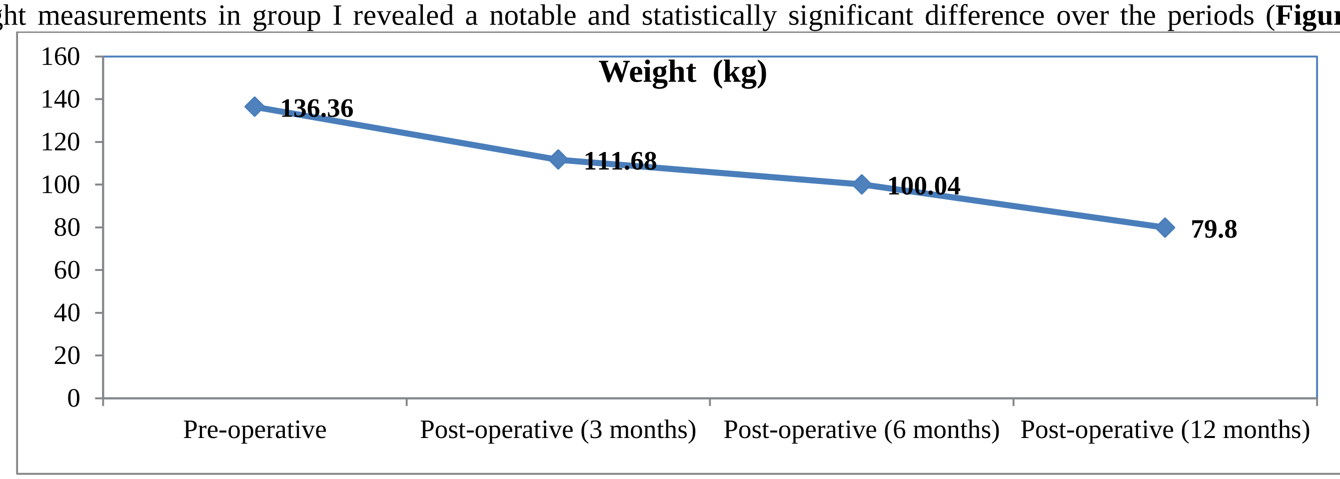

Figure 1: Line shows the difference over the periods regarding weight in group I.

There was highly statistically significant difference over the periods through co-morbidities in group I. Additionally, a highly statistically significant difference in lipid profile was observed over the periods in group I (**Table 3**).

Table 3: The extent of the difference over the periods through co-morbidities and lipid profile in group I (Number of patients = 25).

Co-morbidities	Pre-operative	Post-operative (3 months)	Post-operative (6 months)	Post-operative (12 months)	p-value
DM					
HbA1c					
Mean±SD	10.92±1.19	8.80±0.91	7.86±0.93	6.06±0.87	<0.001**
Range	9-13	7-11	6-10	5-8	
FBS					
Mean±SD	176.80±15.47	138.40±10.28	128.80±13.33	101.00±21.41	<0.001**
Range	150-210	120-160	100-150	70-140	
HOMA					
Mean±SD	8.20±1.19	7.20±0.96	6.20±0.91	2.36±1.29	<0.001**
Range	6-10	6-9	5-8	1-5	
Treatment					
Insulin	12(48.0%)	3 (12.0%)	0 (0%)	0 (0%)	<0.001**
Oral	13 (52.0%)	8 (32.0%)	16 (64.0%)	2 (8.0%)	
Stopped	0 (0.0%)	14 (56%)	9 (36.0%)	23 (92%)	
HTN	12 (48.0%)	9 (36.0%)	4 (16.0%)	3 (12.0%)	0.013*
Lipid Profile					
TG					
Mean±SD	193.40±32.01	157.60±20.47	145.92±23.67	120.40±13.61	<0.001**
Range	140-300	120-200	90-190	95-145	
Cholesterol					
Mean±SD	232.00±18.93	215.20±14.75	200.00±13.54	185.60±9.61	<0.001**
Range	190-260	180-240	170-230	160-200	
LDL					
Mean±SD	166.40±12.21	156.40±12.21	132.80±13.08	114.40±8.21	<0.001**
Range	140-190	130-180	100-150	100-130	
HDL					
Mean±SD	47.04±4.83	49.76±4.47	53.20±4.50	56.00±11.08	0.005*
Range	41-57	44-59	47-62	6-64	
Serum ferritin					
Mean±SD	---	82.80±32.73	71.32±35.22	77.60±35.94	0.586
Range	---	30-150	8-145	10-150	

DM: Diabetes Mellites, HbA1c: Hemoglobin A1c, FBS: Fasting blood sugar, HOMA: Homeostatic model assessment, HTN: Hypertension, TG: Triglycerides, LDL: Low-density lipoproteins HDL: Heigh density lipoproteins, *: Significant, **: Highly Significant

(In tables 3 and 4, to compare the same group at different times, you should use repeated measures ANOVA test instead of one-way ANOVA test, and if P was significant, then you should also use another post hoc test so as to compare results of each time period with each other time period).

(Repeated measures ANOVA test is not suitable to compare HOMA and Serum ferritin in table 3 because samples are not normally distributed. Use another suitable test, e.g., Friedman test, and if P was significant, then you should also use another post hoc test so as to compare results of each time period with each other time period).

There was a highly statistically significant difference over the periods regarding weight measurements in group II (**Figure 2**).

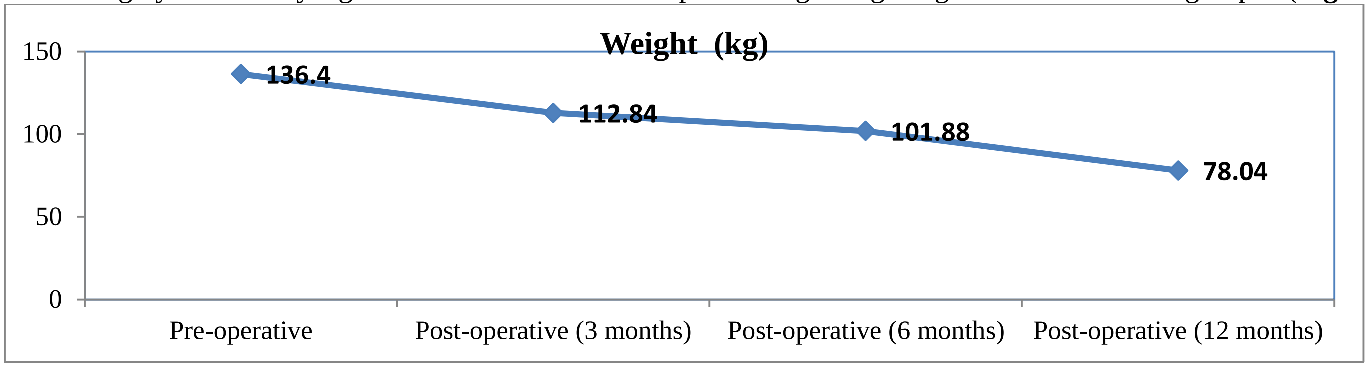

Figure 2: Line shows the difference over the periods regarding weight in group II.

Regarding co-morbidities, group II exhibited a highly significant statistical difference over the periods. Also, there was a highly statistically significant difference over the periods through lipid profile in group II (**Table 4**).

Table 4: The extent of the difference over the periods through co-morbidities and lipid profile in group II (Number of patients = 25).

	Co-morbidities	Pre-operative	Post-operative (3 months)	Post-operative (6 months)	Post-operative (12 months)	p-value
DM						
HbA1c	Mean±SD	11.36±1.15	8.60±1.00	7.90±1.37	6.02±0.96	<0.001**
	Range	9-13	7-10	6-11	5-8	
FBS	Mean±SD	182.00±17.80	139.96±13.51	127.20±17.20	93.84±27.54	<0.001**
	Range	150-210	120-170	100-160	9-150	
HOMA	Mean±SD	7.64±1.25	6.96±1.02	5.88±1.05	2.36±1.19	<0.001**
	Range	6-10	5-8	4-7	1-5	
Treatment	Insulin	8 (32.0%)	5 (20%)	0 (0.0%)	0 (0%)	<0.001**
	Oral	17 (68.0%)	15 (60%)	8 (32.0%)	5 (20.0%)	
	Stopped	0 (0.0%)	5 (20%)	17 (68.0%)	20 (80.0%)	
	HTN	11 (44.0%)	11 (44.0%)	5 (20.0%)	4 (16.0%)	0.046*
Lipid Profile						
TG	Mean±SD	216.80±35.91	176.00±18.71	166.60±17.72	132.80±17.68	<0.001**
	Range	120-280	150-230	140-220	100-160	
Cholesterol	Mean±SD	226.40±17.29	205.60±15.83	189.20±11.15	165.60±10.03	<0.001**
	Range	200-260	170-240	160-210	150-180	
LDL	Mean±SD	168.00±13.84	154.00±14.14	131.20±13.01	112.80±7.37	<0.001**
	Range	140-190	130-180	110-160	100-120	
HDL	Mean±SD	47.52±6.04	50.76±4.62	54.88±4.35	59.00±2.89	<0.001**
	Range	41-65	44-62	50-65	55-64	
Serum ferritin	Mean±SD	---	79.60±32.59	61.16±37.01	66.44±38.22	0.193
	Range	---	20-120	5-110	6-120	

DM: Diabetes Mellites, HbA1c: Hemoglobin A1c, FBS: Fasting blood sugar, HOMA: Homeostatic model assessment, HTN: Hypertension, TG: Triglycerides, LDL: Low-density lipoproteins HDL: Heigh density lipoproteins, *: Significant, **: Highly Significant

(Repeated measures ANOVA test is not suitable to compare FBS and Serum ferritin in table 4 because samples are not normally distributed. Use another suitable test, e.g., Friedman test, and if P was significant, then you should also use another post hoc test so as to compare results of each time period with each other time period).

DISCUSSION

In their study on intraoperative bleeding, **Rutledge and Walsh** documented the occurrence of complications in 142 out of 2,410 patients who underwent laparoscopic MGB (5.9%). The mortality rate was 0.08 %, the leakage rate was 1.08%, and 0.17% of the MGB was converted to open. Infections of the wounds affected 0.12% of the patients, while 0.08% developed wound hernias. Medication was administered to the 97 patients (4%) who developed ulcers. Three patients whose ulcer treatment failed medical intervention underwent a revision of the MGB [7].

In our study, regarding other complications, no cases of anastomotic stenosis were observed, in contrast to the findings of a study conducted by **Brian, Mitzman** in 2016, which presented that A stricture requiring dilatation in the gastric sleeve, resulting in dysphagia, was observed in a single patient out of a case series consisting of 123 individuals [8].

Regarding the changes in the BM, **Sánchez-Pernaute *et al.*** made a case series that was conducted on 100 patients who presented with morbid obesity or metabolic disease and were treated with SADI-S. At the 12-month mark, the average excess weight loss (EWL), which was determined using the ideal BMI of 25 kg/m2, was 95%.[9].

When compared to a study that was performed by **Sánchez-Pernaute *et al.***, in a case series comprising 97 patients with type 2 diabetes and obesity who received SADI-S treatment, the EWL demonstrated an increase of 73% at six months, 91% in the first year, 92% in the second postoperative year, 85% in the fifth year, and 98% in the sixth year. Six patients did not attain 50% EWL during the follow-up (6.1%). The patients experienced a cumulative weight loss of 31% six months, 39% one year, 39% two years, 35% three years, 37% four years, and 38% five years following the weight loss procedure [9].

Sánchez-Pernaute *et al.*, indicated that follow-up data for 50 patients was accessible two years after the implementation of SADIS. The EWL was as follows: 114% at the 2-year, 53% at 18 months, 94.7 % at 1 year, 87.8% at 9 months, 81.6 % at 6 months, and 0.6 % at 3 months. The average preoperative BMI was 44.2 kg/m^2, with a range of 33.2 to 67 kg/m^2 [9].

Demaria *et al.*, stated that prospective study involving 109 patients examined the impact of MGB on BMI among T2DM patients who had preoperative BMIs below 35 kg/m^2. The average BMI reduction observed was (6.6 ± 2.2 kg/m^2), which closely aligns with the results obtained in our own research [10].

de Sa *et al.*(14), also in a study comparable to that of **Demaria *et al.***(13) found that 27 patients with average BMI loss was (7.8 ± 1.2) post MGB surgery in patients with preoperative BMIs < 35 kg/m^2.

In the investigation conducted by **Sánchez-Pernaute *et al.*** on 97 patients who underwent SADIS, the postoperative glucose level was observed. The study revealed that the overall diabetes remission rate (defined as HbA1c levels below 6 % for a minimum of one year without anti-diabetic medication) was 52% after five years and 77% after two years[9].

Comparing our findings to those of other studies reveals that the universally published data indicate comparable results. Nevertheless, it has been observed that remission rates exhibited considerable variation, ranging from 77% to 88%, owing to the absence of a universally accepted definition of diabetes remission. The efficacy of bariatric surgery and diabetes remission may have been overestimated to some degree. 44 patients with a BMI below 35 kg/m^2 were enrolled in a prospective study by **Lee *et al.*** to determine the impact of MGB on T2DM. In their study, 77% of patients achieved the ADA-recommended thresholds for triglycerides (< 150 mg/dL), HbAlC (< 7%), and LDL (< 100 mg/dL) [11].

Lakdawala *et al*. concluded that 52 patients with a mean BMI of 32.6 kg/m^2, 73.1% had reached remission of T2DM (HbA1c < 6.0% and FBG < 126 mg/dl without use of medications and on free diet) at the end of follow up [12].

Lanzarini *et al*. described that at mean BMI of 33.1 kg/m^2, 93.6% of 31 patients achieved remission of T2DM (HbAlc <6 % and FBG <100 mg/dl) concluding the follow-up[13].

Our study identified a positive correlation between blood pressure reduction and remission of diabetes. Nevertheless, the lack of statistical significance in this correlation implies that the facilitation of postoperative diabetes resolution may be influenced more by mechanisms other than weight loss. C-peptide levels and operative techniques were found to be significant predictors of T2DM remission in obese patients, according to a retrospective study by **Lee and his colleagues** that compared various gastrointestinal surgeries (LSG, LMGB, and LGB) among patients with different waist circumferences [11].

Milone and his colleague concluded that a high preoperative HBAlc level did not serve as a favourable predictor of diabetes remission within a 12-month period. In addition, neither the percentage changes between blood glucose level and BMI after MGB from baseline to 12-month follow-up nor changes in HbAlc levels and BMI after MGB exhibited any statistically significant correlations [14].

Various studies have provided evidence that metabolic surgery offers additional advantages beyond the reduction of hyperglycemia. These benefits also encompass the enhancement of cardiovascular risk factors, including hypertension and dyslipidemia. **Buchwald *et al*.** indicated that bariatric procedures resulted in a significant reduction in the concentrations of total cholesterol, triglycerides, and LDL cholesterol. Approximately 70% of the patients documented a reduction in their hyperlipidemia. A resolution or reduction in hypertension was noted in 79% of the patients [1]. **Ahmed *et al.*** indicated that a prospective study involving 100 patients reported a hypertension remission rate of 66%, which may have been attributed to a hormonal mechanism. Diverse neuroendocrine changes have also been hypothesised to contribute to this result. The initial enhancement in glycemic control following bypass has been attributed by certain individuals to the gut peptide glucagon-like peptide 1 [15].

CONCLUSION

Surgical treatment of T2DM is gaining increasing attention due to the significant influence that weight loss procedures have on glucose metabolism. Carefully selected patients with metabolic syndrome may undergo metabolic surgery without risk. A therapeutic focus is necessary for individuals at high risk due to the heightened susceptibility to T2DM and cardiovascular disease. According to the findings of our research, SADIS and MGB exhibit comparable efficacy in managing hypertension, diabetes mellitus, and hyperlipidemia.

- **Sources of funding:** Nil
- **Author contribution:** Authors contributed equally in the study**.**
- **Conflicts of interest:** Nil.

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