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A retrospective study to evaluate the effect of Laparoscopic sleeve gastrectomy on Type 2 Diabetic Morbid Obese patients by comparing HbA1c levels before and after surgery

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Abstract

Background and Objectives: Morbid obesity is a significant risk factor for type 2 diabetes. Bariatric surgery improves glycemic control in obese individuals. Laparoscopic sleeve gastrectomy (LSG) is a commonly performed bariatric procedure. This retrospective study evaluated the effect of laparoscopic sleeve gastrectomy (LSG) on glycaemic control in morbidly obese patients with prediabetes and diabetes by comparing pre- and post-surgery hemoglobin A1c (HbA1c) levels.

Methods: This retrospective study analysed data from morbidly obese patients who underwent LSG at the Emirates Health Services, Khorfakkan Hospital in Sharjah Emirate of the United Arab Emirates between January 2018 and January 2023 by analysing blood pressure, lipid profiles, and blood sugar levels during pre- and post-surgery.

Results: This study included 156 patients who had a mean age of 30.46 ± 9.9 years and predominantly were female (64.7%). The majority of the patients (70.5%) had no comorbidities. The mean blood pressure was 121.41 ± 13.22 mmHg systolic and 70.718 ± 10.34 mmHg diastolic. Lipid profiles showed mean total cholesterol of 4.873 ± 0.90 mmol/L, triglycerides of 1.249 ± 0.72 mmol/L, and HDL of 1.225 ± 0.28 mmol/L. Mean random blood sugar was 6.186 ± 2.67 mmol/L, and mean hospital stay was 2.436 ± 0.95 days. After the surgery, the mean weight loss significantly decreased from 96.37 kg to 78.77 kg ($p = 0.001$). There were significant reductions in HbA1c levels across all patient groups: non-diabetic patients showed a mean decrease of 0.174 ($p = 0.01$), pre-diabetic patients a mean decrease of 0.671 ($p = 0.001$), and diabetic patients a mean decrease of 1.99 (p-value = 0.005) after 6 months post-surgery.

Conclusion: This study demonstrated that LSG is associated with significant improvements in glycaemic control in morbidly obese patients with prediabetes and diabetes, as evidenced by reductions in HbA1c levels.

Keywords: Laparoscopic Sleeve Gastrectomy, Prediabetes, Type 2 Diabetes, Obesity, HbA1c, Weight loss.

Introduction

Global health systems around the world face serious challenges due to obesity and its associated comorbidities, which include hypertension, stroke, non-alcoholic fatty liver disease (NAFLD), renal failure, dyslipidemia, and type 2 diabetes mellitus (T2DM).[1] The economic and psychological costs of obesity are increasing.[2] Since 1975, the number of obese people worldwide has almost tripled, and by 2040, diabetes is predicted to increase by 200 million cases, becoming an even bigger global public health concern.[3] Although conservative management of obesity with medical treatment and lifestyle changes frequently results in high failure rates and poor long-term outcomes, obesity is a major risk factor for non-communicable diseases such as diabetes, cardiovascular diseases, musculoskeletal problems, and certain malignancies [4]

The risk of noncommunicable diseases, such as diabetes, increases with rising BMI, and while significant weight loss can ameliorate or even remit diabetes, current lifestyle interventions and pharmacotherapy often fail to achieve long-term weight loss and glycaemic control, making improved glycaemic control a crucial treatment objective.[5] With its ability to provide sustained weight loss, control of obesity-related comorbidities, and a decreased risk of cardiovascular events and death, metabolic surgery has become a popular treatment for morbidly obese patients seeking long-term weight loss and remission of type 2 diabetes mellitus (T2DM) [6,7]

In obese individuals with type 2 diabetes and metabolic syndrome, including dyslipidemia, bariatric surgery has been demonstrated to not only lower diabetes-related morbidities but also achieve successful and long-term glycaemic control, exceeding extensive lifestyle adjustments and appropriate medication therapy.[8] Obesity surgery, such as sleeve gastrectomy (SG) and Roux-en-Y gastric bypass (RYGB), is now acknowledged as a proven therapeutic option for treating obesity and type 2 diabetes mellitus (T2DM) at the same time. It offers notable improvements in metabolic disorders and weight loss.[9] The choice of a particular bariatric treatment is still debatable because more recent meta-analyses do not support early findings that Roux-en-Y gastric bypass (RYGB) provides better glycemic control for patients with type 2 diabetes than sleeve gastrectomy (SG).[9, 10] Now that the short- and long-term metabolic outcomes of this strategy have been confirmed, [11,12], it is becoming more and more well-liked globally and is being considered in the ongoing discussion about which metabolic procedure works best for these individuals.

An effective bariatric operation for treating morbid obesity and related comorbidities, especially type 2 diabetes mellitus (T2DM), is laparoscopic sleeve gastrectomy (LSG). [13, 14] Originally created as a component of a more involved bariatric treatment, LSG has become increasingly well-known due to its relative ease of use and efficacy. A significant amount of the stomach is removed during surgery, leaving a sleeve-shaped remainder, which not only restricts food intake but also alters gut hormones involved in glucose metabolism, and the resulting decrease in ghrelin levels contributes to reduced appetite and subsequent weight loss. [13,14] The operation has positive effects on comorbidities associated with obesity, such as diabetes mellitus, hypertension, dyslipidemia, obstructive sleep apnea, etc., in addition to weight loss.[15] In diabetic individuals, tracking serial glycated hemoglobin (HbA1c) levels offers information about long-term glucose control. The average blood glucose level during a two- to three-month period (the life span of a red blood cell) is measured by the HbA1c test.

Studies on the use of LSG on T2DM showed significant improvements in glycaemic control and diabetes remission rates.[16] One study reported that 75% of patients achieved diabetes remission one year after LSG, with mean HbA1c levels dropping from 7.3% to 6.1%.[16] Another study observed T2DM remission rates of 78.3%, 76.2%, and 71.4% at 1, 3, and ≥5 years post-LSG, respectively.[17] LSG's efficacy in treating type 2 diabetes goes beyond what is seen in people who are severely obese. Five years following LSG, 52.9% of individuals with class I obesity (BMI 30–34.9 kg/m2) were able to attain HbA1c values below 6.5% without the need of medication.[18] This implies that even in less severe cases of obesity, LSG may be a good choice for managing type 2 diabetes.

HbA1c is a key indicator of long-term glycaemic control in patients with diabetes, and its reduction following LSG has been observed in multiple studies. [19,20] By comparing HbA1c levels before and after LSG, the procedure for diabetes management in morbidly obese patients can be assessed. Zaki et al. showed a positive effect of LSG on glycaemic control in obese patients in the short term, as evidenced by a significant reduction in weight and HbA1c. There was a 30% reduction in BMI and a 26.4% reduction in HbA1c following LSG from baseline in all patients; 44 patients achieved BMI < 40 kg/m^2 with HbA1c <6.5% and 32 patients achieved BMI < 40 kg/m^2 with HbA1c <5.7% within a mean follow-up time of 10 months. [19] This method provides a quantitative assessment of the metabolic effects of LSG beyond weight loss alone and permits the immediate impacts of surgery. This study examined changes in HbA1c values before and after surgery in order to examine the impact of LSG on morbidly obese patients with prediabetes and diabetes. Clinical decision-making and patient counseling regarding the possible metabolic benefits of LSG beyond weight loss alone can be better informed by an understanding of these results.

Materials and Methods

Patients who had Laparoscopic Sleeve Gastrectomy (LSG) at Emirates Health Services' Khorfakkan Hospital in Sharjah Emirate, United Arab Emirates, between January 2018 and January 2023 were the subjects of this retrospective study. The MOHAP Research Ethics Committee's Institutional Review Board gave its approval to this study (approval letter number. MOHAP/DXB-REC/O.N. N /number. 141/2023). There were 156 patients who had LSG in all. Age, gender, and preoperative and postoperative HbA1c levels at six months after surgery were among the demographic information gathered from electronic medical records. The incident report system was used to gather adverse incidents. The patient's identity was coded and kept private. SPSS version 21 was used for statistical analysis. At a significance level of 5%, paired t-tests were used to evaluate weight reduction and HbA1c levels within the group at various time points (pre-vs. post).

Results

The mean age of the 156 patients in the study was 30.46 ± 9.9 years, with the youngest participant being 18 years old and the oldest being 58 years old. The majority of patients (35.9%) were in the 21-30 years age group, followed by 28.2% in the 31-40 years age group. The 15-20 years age group accounted for 18.6% of the patients, while 14.1% were in the 41-50 years age group. Only 3.2% of the patients were in the oldest age group (51-60 years). The majority of the patients (nearly two-thirds) were females (64.7%) compared to males (35.3%). Among the 156 patients, the majority (70.5%) did not have any comorbidities and approximately 29.5% of the patients had one or more comorbidities. (Table 1)

Table 1: Distribution of mean age, age groups, gender and comorbidities among the patients

	N	Minimum	Maximum	Mean	SD
Age	156	15.0	58.0	30.46	9.90
Age groups	**Frequency (n)**			**Percent (%)**	
15 to 20 years	29			18.6	
21 to 30 years	56			35.9	
31 to 40 years	44			28.2	
41 to 50 years	22			14.1	
51 to 60 years	5			3.2	
Total	156			100.0	
Gender	**Frequency (n)**			**Percent (%)**	
Females	101			64.7	
Males	55			35.3	
Total	156			100.0	
Co-morbidities	**Frequency (n)**			**Percent (%)**	
No	110			70.5	
Yes	46			29.5	
Total	156			100.0	

The clinical profiles of 156 patients are shown in Table 2. The average blood pressure readings were 70.718 ± 10.34 mmHg for the diastolic and 121.41 ± 13.22 mmHg for the systolic. A mean total cholesterol (TC) level of 4.873 ± 0.90 mmol/L, with a range of 2.80-8.85 mmol/L, was found by the lipid profile. The average levels of high-density lipoprotein (HDL) and triglycerides (TG) were 1.225 ± 0.28 mmol/L and 1.249 ± 0.72 mmol/L, respectively. The average length of hospital stay was 2.436 ± 0.95 days, with a range of 1–7 days, and the average random blood sugar (RBS) level was 6.186 ± 2.67 mmol/L, with a range of 4.30–19.10 mmol/L.

Table 2: Mean blood pressure, lipid profile, RBS, length of hospital stays of the patients

Parameters	N	Minimum	Maximum	Mean	SD
Systolic blood pressure	155	90	158	121.41	13.22
Diastolic blood pressure	156	45.0	99.0	70.718	10.34
Total cholesterol	140	2.80	8.85	4.873	0.90
Triglycerides	149	0.30	5.52	1.249	0.72
High density lipoprotein	145	0.40	1.93	1.225	0.28
RBS	61	4.30	19.10	6.186	2.67
Length of hospital stay	156	1.0	7.0	2.436	0.95

Table 3, Figure 1 and 2 presents a detailed comparison of the mean weight loss and HbA1c levels in patients before and after the surgical intervention, with data collected over a period of 6 months. The results indicated significant improvements in both weight loss and HbA1c levels in all patients following the surgical intervention. The mean weight loss was significantly decreased from 96.37 kg in the preoperative period to 78.77 kg in the postoperative period, with a mean difference of 17.64 kg ($p = 0.001$). In Non-Diabetic (< 5.7) patients, before surgery, 61 patients had HbA1c levels ranging from 4.10 to 5.69, with a mean of 5.238 ± 0.305. After 6 months, data from 39 patients showed HbA1c levels ranging from 4.00 to 6.00, with a mean of 5.048 ±0.410. The mean difference in HbA1c level was 0.174, which was statistically significant ($p = 0.01$). In pre-diabetic (5.7–6.5) patients preoperatively, 68 patients had HbA1c levels between 5.70 and 6.50, with a mean of 6.015 ± 0.217. Postoperatively, data from 45 patients showed HbA1c levels ranging from 4.40 to 6.90, with a mean of 5.364 ± 0.403. The mean difference in HbA1c level was 0.671, which was statistically significant ($p = 0.001$). In diabetic (> 6.5) patients, before surgery, 23 patients had HbA1c levels ranging from 6.57 to 14.50, with a mean of 7.704 ± 2.186. After 6 months, data from 20 patients showed HbA1c levels ranging from 4.30 to 11.50, with a mean of 5.809 ± 1.485. The mean difference in HbA1c levels was 1.99, which was statistically significant ($p = 0.005$).

Table 3: Comparison in the mean weight loss and HbA1c from pre to postoperative period after 6 months using paired t test

Parameters	Time Interval	n	Minimum	Maximum	Mean	SD	Mean diff	p value
Weight Loss	Pre-op	133	72.0	138.8	96.37	14.64	17.64	0.001*
	Post-op	150	54.0	118.0	78.77	12.43		
< 5.7 (Non-diabetic)	Pre-op	61	4.10	5.69	5.238	0.305	0.174	0.01*
	Post-op	39	4.00	6.00	5.048	0.410		
5.7 to 6.5 (prediabetic)	Pre-op	68	5.70	6.50	6.015	0.217	0.671	0.001*
	Post-op	45	4.40	6.90	5.364	0.403		
>6.5 (Diabetic)	Pre-op	23	6.57	14.50	7.704	2.186	1.99	0.005*
	Post-op	20	4.30	11.50	5.809	1.485		

*Significant

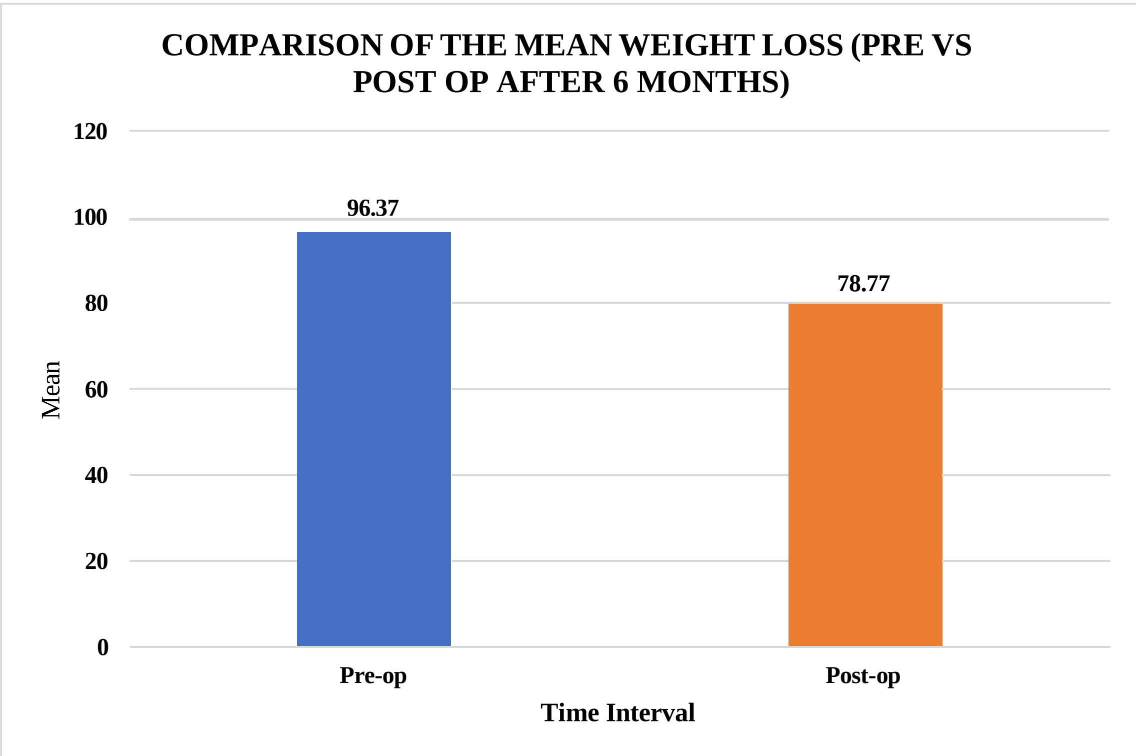

Figure 1: Comparison of the mean weight loss (pre vs post op after 6 months)

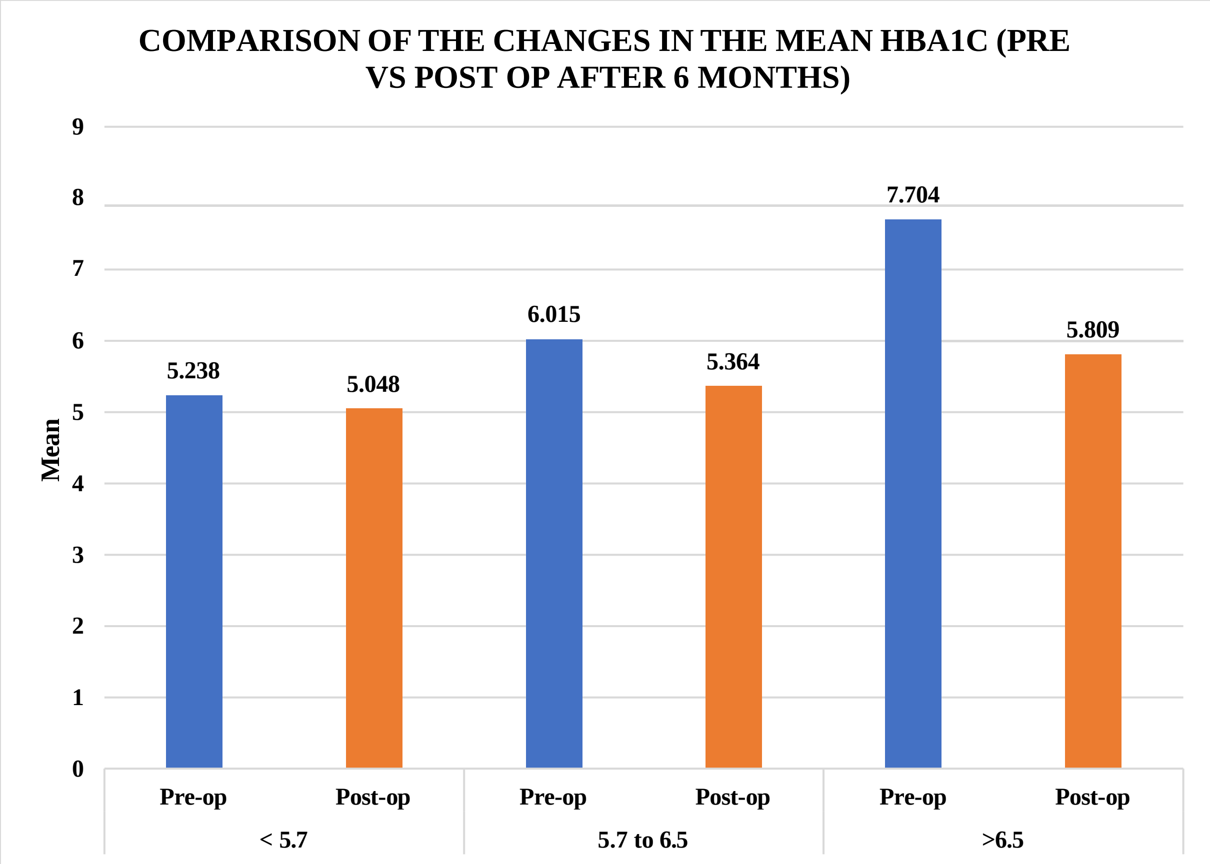

Figure 2: Comparison of the changes in the mean hba1c (pre vs post op after 6 months)

Discussion

The general definition of obesity is a condition marked by an excessive buildup of body fat over time that may have negative health effects. Obesity is defined as having a body mass index (BMI) of >30 and overweight as having a BMI >25. Higher-than-optimal BMI was expected to be the cause of 5 million noncommunicable disease (NCD) deaths in 2019.[21] Since the importance of obesity primarily depends on consequences from its associated comorbidities, it is becoming a global health concern. It can be challenging to move from obesity to a normal BMI range (18.5-24.9) [22] with diet, exercise, and medication, particularly if the patient has a very high BMI; also, there is a significant risk of weight gain. Ghrelin and leptin, two hormones that regulate appetite and hunger, have been researched in connection with diet. These hormones appear to be more prevalent in obese persons, which makes diet challenging and may even cause patients to suffer from famine. Because hormone levels can stay high even after weight loss, maintaining weight requires vigilance, and the maintenance period may last forever. [23–25] There is mounting evidence that the decrease in body mass index (BMI) following LSG, in which the stomach shrinks by approximately 75% of its initial size [26], is influenced by neuro-hormonal variables in addition to the reduction in stomach size [27]

According to recent research, LSG has demonstrated outstanding results in terms of weight loss and the amelioration of comorbidities associated with obesity. Comorbidities, including obstructive sleep apnea, dyslipidemia, and hypertension, have already been demonstrated to be treated by it.[28] LSG may therefore be suggested as a treatment for diabetic patients who have elements of the metabolic syndrome.[29] Instead of using a variety of conservative medical therapies that put a pressure on the healthcare system—which frequently does not have a high failure rate in these settings—this would be a very successful and economical management strategy. Independent of BMI criteria, there is not enough data to support the recommendation of bariatric surgery for glycaemic management, lipid reduction, or cardiovascular disease risk reduction alone. The reduction in HbA1c levels in pre-diabetic patients (mean decrease of 0.671) and diabetic patients (mean decrease of 1.99 at six months postoperatively) at six months postoperatively indicated a significant improvement in glycaemic control and significant weight loss. This aligns with findings from the recent literature, which also emphasizes the effectiveness of various interventions in managing T2DM. The Diabefly program reported a mean HbA1c reduction of 1.69% from a baseline of 8.66%, alongside significant weight loss, indicating effective management of T2DM through digital therapeutics.[30] A study on sleeve gastrectomy showed a 3.0% reduction in HbA1c and 22% weight loss at six months, underscoring the surgical approach's efficacy.[31] The mechanism underlying the improvement in glycaemic control after LSG is multifaceted. While weight loss plays a crucial role, other factors such as changes in gut hormones and improved insulin sensitivity also contribute to the observed effects. [32,33]

In the present study, the mean age of the 156 participants was 30.46 ± 9.9 years, ranging from 18 to 58 years. The age distribution was primarily in younger cohorts, and only 3.2% of the participants were aged 51-60 years. This distribution reflects a younger population compared to other studies, in which older age groups are more prevalent. A recent study focused on paediatric patients (ages 5-14) undergoing LSG, demonstrating significant reductions in HbA1c from 6.0% to 5.4% post-surgery, indicating effective metabolic outcomes in a younger demographic.[34] In contrast, studies involving older cohorts, such as those with a mean age of 41.6 years, reported varying results, with 52.9% achieving HbA1c levels below 6.5% after five years.[18] Younger patients may experience more pronounced metabolic benefits from LSG, as evidenced by the rapid improvement in glucose homeostasis observed in studies with younger cohorts.[35] The effectiveness of LSG in younger populations suggests a potential for earlier intervention in obesity-related type 2 diabetes, which could mitigate long-term complications.[35]

The gender distribution showed that nearly two-thirds of the patients were female (64.7%), which indicates that females are seeking bariatric surgery more than males. This aligns with findings from other studies that observed a predominance of females in similar settings.[36] In terms of comorbidities, 70.5% of the patients reported none, whereas 29.5% had one or more comorbidities. In contrast, a study by Siptar et al., found that 51.7% of patients had hypertension and 13.8% had type 2 diabetes, indicating a higher prevalence of comorbidities.[37] Mostafa et al. highlighted that among adolescents, LSG led to significant improvements in glycaemic control, suggesting that comorbidities like diabetes are prevalent but manageable post-surgery.[38]

The mean systolic and diastolic blood pressures were 121.41 ± 13.22 mmHg and 70.718 ± 10.34 mmHg, respectively. Studies have indicated significant reduction in blood pressure following LSG. Wysocki's research noted that patients experienced lower mean daily glucose levels, which correlates with improved blood pressure control post-surgery.[39] Singh et al. reported that 5 years post-surgery, many patients achieved better metabolic control, including blood pressure normalization.[18] Elbalshy et al. found that 80% of patients showed improvement in diabetes management post-LSG, with many achieving remission.[36] This suggests a potential link between improved glycaemic control and blood pressure stabilization. Asiri et al. highlighted significant HbA1c reductions in children post-surgery, indicating that LSG can effectively manage diabetes across age groups.[34]

The study demonstrated a significant weight loss from 96.37 kg pre-operatively to 78.77 kg postoperatively, with a mean difference of 17.64 kg ($p = 0.001$). This weight loss is consistent with outcomes reported in surgical weight loss studies, where significant reductions are often observed.[40] Similarly, the mean HbA1c level decreased significantly from 5.96% to 5.33% ($p = 0.001$), reflecting improvements in glycaemic control. In diabetic patients, the mean HbA1c level significantly decreased from 7.565% to 5.781% among those with HbA1c > 6.5% ($p = 0.003$), and for patients with HbA1c < 6.5, the mean HbA1c level significantly decreased from 5.627% to 5.197% ($p = 0.003$). This decrease is similar to the results that observed significant HbA1c reductions postoperatively.[41]

Another analysis that examined 27 trials and 673 individuals examined the impact of LSG on obese patients with type 2 diabetes. It found that the condition improved in 26.9% of patients, resolved in 66.2% of patients, and remained stable in 13.1% of patients. Following an LSG, the average drop in HbA1c levels was -1.7%.[42] Reductions in body weight, calorie intake, and inflammatory mediators may all contribute to improved insulin sensitivity. Hormonal modulation is important, according to some studies. According to recent research, LSG is linked to a significant decrease in the secretion of ghrelin, a hormone that the stomach fundus produces and that regulates appetite at mealtimes. After a meal, when the stomach is expanded, ghrelin secretion ceases. Ghrelin is released when the stomach is empty.[43, 44] By preventing insulin secretion, it also contributes to the regulation of glucose homeostasis.[25] Ghrelin levels are lowered by LSG, which causes an increase in insulin secretion.[45] 90% of patients had ghrelin levels that are permanently reduced following LSG, according to research by Bohdjalian et al. (2010) and Gagner et al. (2009).[46, 47] The majority of ghrelin synthesis takes place in the stomach fundus, which is removed during LSG. This decrease is even more pronounced than what is seen during gastric bypass.[48] Ghrelin is also known to enhance growth hormone, cortisol, and epinephrine, which are all known to have diabetogenic effects. Consequently, its inhibition may help to promote better glucose homeostasis [48,50].

Our findings concurred with those of Guo et al., who performed LSG on 34 obese individuals with type 2 diabetes and a BMI of less than 40 kg/m2.[51] Furthermore, during a 3-year follow-up, Abbatini et al. demonstrated an 80.9% remission of T2DM following LSG.[52] In non-diabetic patients (HbA1c < 5.7), 61 patients had preoperative HbA1c levels of 4.10-5.69 with a mean of 5.238 Â ± 0.305. After 6 months, 39 patients showed HbA1c levels of 4.00-6.00 with a mean of 5.048 ± 0.410, indicating a statistically significant mean difference of 0.174 ($p = 0.01$). In pre-diabetic patients (HbA1c 5.7-6.5), 68 patients had preoperative HbA1c levels of 5.70-6.50 with a mean of 6.015 ± 0.217, which decreased to 5.364 ± 0.403 postoperatively, showing a significant mean difference of 0.671 ($p = 0.001$). For diabetic patients (HbA1c > 6.5), 23 patients had preoperative HbA1c levels of 6.57-14.50 with a mean of 7.704 ± 2.186, reducing to 5.809 ± 1.485 after 6 months, with a significant mean difference of 1.99 (p-value = 0.005) was observed in the present study. These findings are consistent with previous research demonstrating effective glycaemic management post-surgery.[51] Overall, the study's findings support the efficacy of the therapies and are consistent with previous research. These results are similar to those of Wei-Jee Lei et al., who demonstrated that the median HbA1c drop among 20 type 2 diabetic patients treated with LSG was from 10.1% to 7.1%.[53] At three and six months following surgery, the Adel study found a significantly significant decrease in mean HbA1c levels ($p<0.001$). LSG may therefore be a viable choice for the treatment of type 2 diabetes in obese patients.

Undoubtedly, bariatric surgery is now becoming a viable treatment option for T2DM in obese patients, as evidenced by recent extensive research that demonstrate its advantages over conventional medical care.[54] Large-scale research on LSG is still lacking, though, especially when it comes to diabetes resolution. This is because, with a T2DM remission rate of up to 60%, Roux enY gastric bypass (RYGB) continues to be the gold standard bariatric treatment.[55] Recent data, however, indicates that there is no discernible difference between RYGB and LSG in the treatment of type 2 diabetes, with both procedures producing results that are comparable in terms of diabetes control.[41] T2DM had resolved in 51.4% and 62.0% of patients who underwent LSG and LRYGBP, respectively, according to another prospective study by Vidal et al. on the changes in glucose homeostasis in 35 severely obese T2DM patients undergoing LSG and 50 patients undergoing laparoscopic Roux-en-Y gastric bypass (LRYGBP) at 4 months after surgery ($p=0.332$). This demonstrated that after four months following surgery, the rate of type 2 DM remission is comparable for LSG and LRYGBP.[56] Pre-diabetic and diabetic patients showed significantly different rates of weight loss and HbA1c reduction, according to the current study. This implies that LSG may work well to treat the illness, no matter how severe it is. During the course of the trial, no adverse reactions (ADRs) were noted. There were certain restrictions on our investigation. The sample size was small, to start. Second, for six months, only brief follow-up was conducted. To assess the long-term advantages of bariatric surgery in relation to diabetes outcomes, more study is necessary.

Conclusion

Significant improvements were observed postoperatively, including weight loss and a notable reduction in HbA1c levels, reflecting effective outcomes in weight management and glycaemic control among patients in the non-diabetic, pre-diabetic, and diabetic populations. These results offer compelling proof that laparoscopic sleeve gastrectomy is effective in producing notable health benefits in terms of glycaemic control and weight management.

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