



Metabolic Outcomes of Laparoscopic Sleeve Gastrectomy: Short and Mid-Term Effects on Type 2 Diabetes and Hypertension in Patients with Obesity

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Abstract

Introduction Laparoscopic sleeve gastrectomy (LSG) has become a frequently employed primary bariatric procedure in recent years. Our objective was to evaluate the short- and mid-term outcomes of LSG with regard to weight reduction and its impact on associated comorbidities, particularly hypertension (HTN) and type 2 diabetes mellitus (T2DM).

Materials and Methods 86 patients who underwent LSG between June 2015 and December 2022 and whose postoperative 6-month, 1-year, and 3-year follow-up records were available were included in this retro-prospective study. Preoperative height/weight values, comorbidities, drugs used for HTN and/or T2DM, and changes in postoperative 6-month, 1-year, 3-year, and 5-year data were collected.

Results compared to preoperative data, decrease in Body Mass Index (BMI) was statistically significant. Improvement in hypertension was seen in 46.6% of subjects and resolution in 53.4% of study subjects. Resolution in Diabetes was seen in 71% of subjects and improvement in 29% of study subjects.

Conclusion Laparoscopic sleeve gastrectomy (LSG), when used as a primary surgical treatment for morbid obesity, is a highly effective and reliable procedure with low morbidity and mortality rates. Furthermore, it results in significant regression of associated comorbidities, such as hypertension and type 2 diabetes mellitus.

Keywords Sleeve gastrectomy · Comorbidity · Bariatric surgery · Short and midterm results

Introduction

Obesity is an important public health problem; posing a serious burden on the world economy, and its prevalence is steadily increasing in both developing and developed countries [1]. Being overweight is the sixth most important risk factor contributing to the overall disease burden worldwide. Obesity is a risk factor for several comorbidities such

as: cardiovascular diseases, Hypertension (HTN), Type 2 Diabetes Mellitus (T2DM) and dyslipidemia [2].

Failure to achieve adequate weight loss with diet, exercise, and pharmacological treatment has urged researchers to pursue different approaches and have caused current research to focus on hormones and mediators, which are considered a source of obesity, as well as surgical interventions. Although the advantages and disadvantages of many techniques in bariatric surgery have been investigated for many years, a gold standard treatment option has not been determined yet [3]. In the recent years, Laparoscopic Sleeve Gastrectomy (LSG), which had previously been used as the first stage of biliopancreatic diversion, has become the sole bariatric surgery technique and facilitates distinct regression in obesity-associated comorbidities such as HTN, T2DM, hyperlipidemia, asthma, and obstructive sleep apnea [4–9].

In this study, we aimed to investigate the short and midterm effects of LSG, which is performed as the primary bariatric surgery in our hospital, on HTN and T2DM.

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Materials and Methods

Patient Selection

Patients who underwent LSG between June 2015 to December 2022 were retrospectively and prospectively analysed through the hospital information system and patient files. In this period, LSG was performed on 86 patients.

All patients with morbid obesity with diabetes mellitus and hypertension who underwent LSG. Both genders were included. Patients > 18 years of age were included.

Patients with morbid obesity without associated diabetes mellitus and hypertension who underwent LSG, patients < 18 years of age, patients who underwent redo bariatric surgeries, patients with incomplete records and patients who lost follow up were excluded from the study. All the patients were asked to seek professional help for at least 6 months before the surgery in order to lose weight with pharmacological treatment, diet, exercise, and lifestyle changes. Those who failed to lose weight with these methods were recommended LSG according to the indications determined by the National Institutes of Health (NIH) after explaining all of the related risks and complications.

Preoperative Evaluation

Before the surgery, all the patients were evaluated by a team of a bariatric surgeon, an anaesthesiologist, a cardiologist, a gastroenterologist, a psychiatrist, an endocrinologist, a pulmonologist, and a dietician.

Surgical Technique

All LSG operations were performed by the same surgical team. The stomach was separated from the omentum in the direction of the greater curvature beginning from the pylorus 2–3 cm proximal to the cardiac notch, a 32 Fr orogastric tube placed by the anaesthesiologist; the stomach was vertically transected from the antrum to the cardiac notch. Two successive 4.8/60 mm green loads were fired for stapling the antrum, followed by 2–4 successive 3.5/60 mm blue reloads for stapling the remaining corpus and fundus. Hemoclip was applied to the bleeding points on the stapler line. The resected stomach was grasped at the antral end by a laparoscopic grasper through the 12 mm trocar. The first 2–3 cm portion of the resected stomach was grasped into the 12 mm trocar and then the grasper was extracted out together with the trocar and the tip of the resected stomach. After the extraction of the specimen, ryle's tube put in the stomach was irrigated with 0.9% saline solution to detect any anastomotic leak after stapling to deal with it. The 10 mm and 12 mm trocar sites were closed with number 0 polypropylene sutures.

Patients start clear liquid Diet (phase 1) on the 2nd day postoperatively followed by full Liquid Diet (phase 2) from the 3rd day to the end of the 2nd week then semi solid diet (phase 3) through the 3rd and 4th weeks then adjusted regular diet (phase 4) from the 5th week after surgery.

Definitions

To ensure clarity and reproducibility, the criteria used to classify outcomes for T2DM and HTN are defined as follows and were used consistently when scoring outcomes at each follow-up interval.

T2DM Outcomes

Resolution of T2DM HbA1c < 6.5% and fasting plasma glucose (FPG) < 126 mg/dL without the use of any antidiabetic medication for at least 6 months prior to the assessment.

Improvement of T2DM Any of the following: (a) reduction in HbA1c by $\geq 1.0\%$ compared with baseline while still using medications, (b) reduction in the number of antidiabetic agents or dose reduction of at least one agent, or (c) significant improvement in fasting glucose (> 10% decrease) without meeting the criteria for resolution.

HTN Outcomes

Resolution of Hypertension Blood pressure consistently < 140/90 mmHg without antihypertensive medication for at least 6 months prior to the assessment.

Improvement of Hypertension Reduction in number or dose of antihypertensive medications and/or a consistent decrease in BP measurements (systolic and/or diastolic) such that BP control is better than baseline but antihypertensive therapy is still required.

These criteria follow common clinical remission/improvement definitions used in bariatric metabolic literature and were applied to classify each patient's status at 6 months, 1 year, 3 years, and 5 years (where available).

Although the overall cohort consisted of 86 patients, complete 5-year follow-up was available for 23 patients only; therefore, all analyses and conclusions at the 5-year time point are derived from this subgroup.

Statistical Analysis

Patient data including names, age, sex, date of operation, additional categories relevant to the specific goals of this investigation including (preoperative, 1 month, 6 month,

1 year, 2 year, 5 year follow-up) medications, HbA1c%, % EWL at follow-up, and BMI at the time of procedure was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor if SPSS Version 20.0 (SPSS Inc, Chicago, Illinois, USA). Statistical software SPSS (version 29.0) and Microsoft Excel were used to carry out the statistical analysis of data. Continuous variables were expressed as Mean $\pm$ SD and categorical variables were summarized as percentage.

Results

The mean age was 39.4, pre-operative mean weight in kilograms was 107.3, mean height was 156.5 and pre-operative BMI was 43.97.

The mean preoperative BMI was 43.97 ± 5.8 kg/m², which decreased significantly to 30.8 ± 4.5 kg/m² at 1 year, corresponding to a mean %EWL of 64.1% ($p < 0.001$).

Paired analysis demonstrated a significant reduction in HbA1c at all postoperative time points compared with pre-operative values (all $p < 0.001$). Improvements were observed as early as 1 month postoperatively and were sustained up to 5 years in patients with long-term follow-up.

Paired analyses demonstrated a significant reduction in both systolic and diastolic blood pressure beginning at 1 month postoperatively and persisting through 5 years following laparoscopic sleeve gastrectomy (all $p < 0.001$).

Improvement in hypertension is seen in 46.6% of subjects and resolution seen in 53.4% of study subjects.

Resolution of Diabetes is seen in 71% of subjects and improvement in 29% of study subjects.

Table 1 Preoperative mean values of data in study subjects

	N	Mean
Age (In Years)	86	39.4
Pre op Wt. (In Kg)	86	107.3111
Height (In cm)	86	156.5111
BMI Pre-op	86	43.9711

Table 2 Comparison of preoperative and postoperative BMI after laparoscopic sleeve gastrectomy (LSG)

	Timeline	Sample size (n)	BMI (kg/m ²), Mean $\pm$ SD	Mean change from baseline (Δ BMI)	% Excess Weight Loss (%EWL)	p value
Values expressed as mean $\pm$ SD Paired t-test	Pre-op	86	43.97 ± 5.8	—	—	—
	1 month	86	39.9 ± 5.6	-4.1 ± 1.7	19.2 ± 6.1	< 0.001
	6 months	86	36.2 ± 5.3	-7.8 ± 2.6	33.5 ± 8.9	< 0.001
	1 year	86	30.8 ± 4.5	-13.2 ± 4.0	64.1 ± 13.8	< 0.001
	2 years	86	32.4 ± 4.9	-11.6 ± 4.8	59.3 ± 15.7	< 0.001
	5 years	23	33.7 ± 5.4	-10.3 ± 5.2	54.6 ± 17.9	< 0.001

Discussion

Obesity prevalence is increasing around the world, and now over a billion adults have obesity [10]. Obesity is associated with health problems like T2DM and hypertension, although the precise link between these disorders is not understood [11]. Around a third of pre-operative laparoscopic sleeve gastrectomy patients have hypertension, according to Bobowicz et al. One way to alleviate obesity and its associated comorbidities is with bariatric surgery, such as LSG. There are two unique aspects in the field of bariatric surgery. The first is that this surgery involves the alteration of metabolic processes through fundamental changes in appetite, energy regulation, satiety and metabolism, not just simply weight loss. The second is that long term follow-up is essentially important to really gauge the effect of the bariatric surgical procedures on a patient's overall health. Long term studies confirm that bariatric operations result in sustained long term weight loss, alteration in the metabolic consequences of morbid obesity, and a substantial reduction in overall mortality from diabetes, hypertension and cancer.

In our study patients' ages ranged from 18 to 58 years old, with the mean age being 39.4 years old. Maximum number of patients were in the age group of 30–40 years (42.2%) and minimum number of patients were in the age group of 50 to 60 years (8.9%) (Table 1).

In our study before LSG mean values of data were: Weight 107.31(Kg); Height 156.51(cm); BMI 43.97 Kg/m²; HbA1c 8.78(%) (Table 1).

It must be highlighted that the patients with a lower initial BMI, especially those with initial BMI under 40 kg/m², achieve excellent results in terms of %EWL.

In this study the mean preoperative BMI was 43.97 ± 5.8 kg/m², which decreased significantly to 30.8 ± 4.5 kg/m² at 1 year, corresponding to a mean %EWL of 64.1% ($p < 0.001$) (Table 2).

In a study conducted by Carlos Hoyuela in 2017 [12] with the mean follow-up of 32.7 ± 28.5 months (range 6–11) months, the mean % EWL was 82 ± 18.8 at 1 year, 76.7 ± 21.3 at 3 years and 60.3 ± 28.9 at 5 years, which in concurrence with our study (Table 2).

Table 3 Comparison of HbA1c before and after laparoscopic sleeve gastrectomy

Timeline	N	Pre-op HbA1c (%)	Post-op HbA1c (%)	Mean Difference (%)	p-value
1 Month	86	8.6±1.2	7.6±1.1	-1.0	<0.001
6 Months	86	8.6±1.2	6.6±0.9	-2.0	<0.001
1 Year	86	8.6±1.2	6.1±0.8	-2.5	<0.001
2 Years	86	8.6±1.2	6.2±0.9	-2.4	<0.001
5 Years	23	8.7±1.1	6.5±1.0	-2.2	<0.001

Values expressed as mean±SD

Paired t-test

In this study, we explored the application of LSG as a potential metabolic therapy in the treatment of diabetes. The changes seen in HbA1c level observed over the course of study that is mean HbA1c levels at 1 month were 7.6 ± 1.1 , at 6 months 6.6 ± 0.9 , at 1 year 6.1 ± 0.8 , at 2 years 6.2 ± 0.9 , at 5 years 6.5 ± 1.0 , and held a significant association to improvement in diabetes (Table 3).

In this study, Laparoscopic sleeve gastrectomy was associated with a statistically significant reduction in both systolic and diastolic blood pressure at all postoperative follow-up intervals. Improvements were evident as early as 1 month and were sustained through 5 years of follow-up ($p < 0.001$ for all comparisons). Importantly, these favorable effects persisted in the 5-year subgroup despite the smaller sample size, indicating durable long-term blood pressure control following sleeve gastrectomy (Table 4).

Resolution of Diabetes Mellitus was seen in 71% of our study subjects as measured by off medications and return to physiologically normal levels of HbA1c and improvement seen in 29% of study subjects as measured by decreased dose/number of medications and decreased levels of HbA1c (Table 6).

In a study conducted by Schauer PR, et al [12] the authors randomized 150 obese uncontrolled diabetic ($\text{HbA1c} > 7.0$) to intensive medical therapy or to LSG. Surgical groups had significant improvement in HbA1c, weight loss and reduction in the number of antihypertensive and diabetic patients used at 1,2,3 years after randomization, which is concurrence with our study.

Table 4 Comparison of blood pressure after laparoscopic sleeve gastrectomy

Follow up Interval	N	Pre-op SBP (mmHg)	Post-op SBP (mmHg)	p-value	Pre-op DBP (mmHg)	Post-op DBP (mmHg)	p-value
1 Month	86	142±16	135±15	<0.001	90±10	86±9	<0.001
6 Months	86	142±16	130±14	<0.001	90±10	84±8	<0.001
1 Year	86	142±16	128±14	<0.001	90±10	82±8	<0.001
2 Years	86	142±16	129±15	<0.001	90±10	83±9	<0.001
5 Years	23	144±15	130±13	<0.001	92±9	84±8	<0.001

Values expressed as mean±SD

Paired t-test

Table 5 Outcome of HTN after laparoscopic sleeve gastrectomy

	Frequency	Percent	Valid Percent	Cumulative Percent
Improvement	40	46.6	46.6	46.6
Resolution	46	53.4	53.4	53.4
Total	86	100.0	100.0	

Table 6 Outcome of diabetes after laparoscopic sleeve gastrectomy

	Frequency	Percent	Valid Percent	Cumulative Percent
Resolution	61	70.93	71	71
Improvement	25	29.07	29.0	29.0
Total	86	100.0	100.0	

Our study shows that bariatric surgery yields significant improvement and resolution of HTN. Hypertension resolved in 53.4% subjects and improved in 46.6% subjects (Table 5).

These results are consistent with most current guidelines for the management of overweight and obesity in adults [13].

A meta-analysis by Sarkhosh et al. [10] found that LSG resolved HTN in 58% of patients which is concurrence with our study.

Conclusion

With the marked improvement in weight loss after bariatric surgery, the associated comorbid conditions such as diabetes and hypertension also improved resulting in better quality of life in our patients and less need to take many medications.

T2DM resolved in the majority of LSG patients (71%) (Table 6). The LSG effect on hypertension is also beneficial. LSG resolved hypertension in 53% of patients (Table 5).

We concluded that laparoscopic sleeve gastrectomy is a suitable intervention for patients with T2DM and hypertension in patients with morbid obesity.

Author Contributions S.M.A and F.S wrote the main manuscript text.B.A.W prepared tables and Supervised.M.A.S conceptualized and supervised.All authors reviewed theanascript.

Data Availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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