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Original Research Article

Weight regain and associated metabolic impacts on patients in a single center

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ABSTRACT

Background: Obesity is a global health concern, with 4 million people dying in 2017. Bariatric surgery, particularly sleeve gastrectomy, is effective but has been linked to weight regain. Studies show that only 20% of patients can keep weight off, and 60% require additional surgery due to weight regain. This retrospective study aims to measure long-term outcomes of gastric sleeves and associated risk factors.
Methods: A retrospective study utilizing patient records from 2018 to 2023 aims to collect data from the medical records of individuals aged 15-70 years in Prince Sultan Military Medical City (PSMMC). Patients who were under 15 years old or above 70 years old and those who underwent other types of bariatric surgeries or complications not related to the procedures were excluded.
Results: One hundred and forty-one sleeve gastrectomy patients were analyzed. The mean age was 36.8 (SD=12.9) years, with 51.8% being over 35 years old. Additionally, female patients were dominant (70.9%). No significant differences were observed in the mean values of low density lipoprotein (LDL), triglyceride, and cholesterol before and after the surgery ($p>0.05$).
Conclusions: This study has found that sleeve gastrectomy is an effective surgical intervention for significantly improving metabolic parameters, including body mass index (BMI), glycated hemoglobin (HbA1c), blood pressure, creatinine, and high density lipoprotein (HDL) levels. No significant changes were observed for LDL, triglycerides, and total cholesterol. The study suggests that sleeve gastrectomy can lead to durable metabolic benefits irrespective of patient demographics, and further research is needed to evaluate its sustainability.

Keywords: Bariatric surgeries, Weight, Regain, Metabolic

INTRODUCTION

Obesity has emerged as a global health burden as estimates show that about 4 million people died in 2017 due to obesity as the underlying cause.[1] It is a complex and multifactorial condition, influenced by genetic, environmental, and lifestyle factors.[2] As obesity becomes a major public health concern, various treatment modalities have been explored to address this issue, ranging from lifestyle interventions to pharmacotherapy. Among therapeutic options, bariatric surgery is considered an effective and durable solution for individuals with morbid obesity.[3] There are a lot of bariatric procedures widely performed, but the most common procedure is sleeve gastrectomy (SG).[4] SG is a surgical technique that involves the removal of a 75-80% portion of the stomach, leaving behind a tubular structure resembling a sleeve, and

decreasing the stomach size which will limit the amount of food the stomach can hold.[5] This procedure is minimally invasive, and often performed laparoscopically, which reduces the recovery time and postoperative complications.[6] Following sleeve gastrectomy, it is evident that weight regain is significant after long-term follow-up.[7] Most studies have shown that there wasn't long-term weight loss after SG, but some studies have pointed out that weight regain is a significant issue.[8] Despite this, it remains largely undefined, underreported, and poorly understood.

A recently published study in the USA that was a multicenter retrospective study showed that out of all the patients who had SG and were followed up for more than 5 years, only 20% were able to keep the weight off.[9] Moreover, a study was conducted on 782 individuals who underwent obesity surgery in Campinas, São Paulo, Brazil. This study followed the individuals over time and found that weight loss was no longer significant after 24 months, and weight regain became significant after 48 months, with an average increase in body mass index (BMI) of 0.84 kg/m^2 or 4% excess BMI. It showed that weight regained after surgery increased between 24 and 48 months' post-surgery, ranging from 46.0 to 63.6%.[10] In another retrospective study conducted between 2008 and 2014 in a tertiary university medical center in Israel, the findings revealed that patients who had SG were able to maintain significant weight loss in the long term.[11] However, some experienced weight regain or didn't lose enough weight due to certain lifestyle choices. Healthcare providers need to emphasize the connection between postoperative weight loss and specific behaviors.[11] A previous study conducted in Poland has shown that laparoscopic sleeve gastrectomy provides fairly good effects in a long-term follow-up, however, 60% of patients required additional surgery due to weight regain.[12]

Furthermore, an observational prospective cohort study was done in Riyadh King Khalid Hospital on adult patients with morbid obesity undergoing bariatric surgery (sleeve gastrectomy or Roux-en-Y gastric bypass) over six years showed that considerable reduction in weight was observed during the first three years following the surgery.[13] However, the percentage of weight regain was observed among the patients from three years onwards with maximum weight regain after six years from the surgery.[13] Another study conducted 18 months postoperatively at an obesity clinic at King Saud Obesity Research Center, Riyadh showed that weight regain after surgery is primarily caused by unhealthy diet and behavioral lifestyle practices resulting from a lack of nutritional guidance and knowledge.[14]

Therefore, this retrospective study in Prince Sultan Military Medical City, in Riyadh, Saudi Arabia, aims to measure the long-term outcomes of gastric sleeves in terms of weight regain and its impact on associated comorbidities.

METHODS

Study design, preparation, and participants

We conducted a retrospective study utilizing a total of patient records obtained for analysis.

The presenting study was conducted in Prince Sultan Military Medical City (PSMC), Riyadh, Saudi Arabia. The study was designed to be a retrospective study design in which all data was taken from the medical records of patients. Individuals aged 15-70 years in PSMMC, Riyadh, Saudi Arabia who underwent laparoscopic sleeve gastrectomy surgery from January of 2018 until December 2023 were included and they were followed up 1 year post-operatively.

Demographic data included age and gender. Outcomes measured were prevalence of weight regain and will be defined as 20% weight regain compared to maximum weight loss.

Also, we aimed to assess risk factors and comorbidities that were associated with weight regain. The information taken from the PSMMC system will be kept in a secure location, and only individuals with permission will be able to access it. Privacy and secrecy are of utmost importance, and no aspect of this study poses a danger to the confidentiality of participants, nor will the names of participants be disclosed. Patients who were under 15 years old or above 70 years old and underwent other types of bariatric surgeries or complications not related to the procedures were excluded.

Ethical considerations

Ethical approval for this study was obtained from the institutional review board or ethics committee in PSMMC with IRB ID number 708. Patient confidentiality and privacy were strictly maintained throughout the study process. All data were anonymized and de-identified to ensure the protection of patients' rights. Under ethical guidelines, informed consent was not required as this study involved retrospective analysis of existing medical records and imaging data. Nonetheless, every effort was made to uphold the principles of beneficence and non-maleficence in the handling and interpretation of patient information.

Statistical analysis

Descriptive statistics were presented as numbers and percentages (%) for all qualitative variables, while mean and standard deviation were used to present all quantitative variables. A paired t-test was conducted to determine the differences in metabolic parameters before and after sleeve gastrectomy. An Independent sample t-test was used to determine the differences between % excess weight loss and % total weight loss between age and gender. Fischer Exact test was utilized to find out the relationship between the outcome and post-BMI among age and gender. The

normality test was performed using the Shapiro-Wilk test as well as the Kolmogorov-Smirnov test. A p value of 0.05 was used to indicate statistical significance. All statistical data were analyzed using statistical packages for social sciences (SPSS) version 26 (Armonk, NY: IBM Corp, USA).

RESULTS

One hundred and forty-one sleeve gastrectomy patients were analyzed. The mean age was 36.8 (SD=12.9) years, with 51.8% being over 35 years old. Additionally, female patients were dominant (70.9%) (Table 1).

A paired t-test of metabolic parameters before and after the sleeve gastrectomy showed that compared to the preoperative mean values, there were significant reductions in the mean values of BMI (p<0.001), HbA1c (p=0.001), SBP (p=0.036), DBP (p=0.001), creatinine (p=0.014), and HDL (p=0.001) postoperatively. No significant differences were observed in the mean values of LDL, triglyceride, and cholesterol before and after the surgery (p>0.05) (Table 2).

Table 1: Distribution of age and gender (n=141).

Study variables	N (%)
Age in years (mean±SD)	36.8±12.9
≤35	68 (48.2)
>35	73 (51.8)
Gender	
Male	41 (29.1)
Female	100 (70.9)

In Table 3, % excess weight loss showed no significant differences between age group (p=0.360) and gender (p=0.315). Also, % total weight loss showed no significant differences as well as in age group (p=0.208) and gender (p=0.279).

Table 2: Paired t-test of metabolic parameters before and after sleeve gastrectomy (n=141).

Parameters	Before (mean±SD)	After (mean±SD)	P value§
BMI (kg/m^2)	44.7±7.59	32.9±5.71	<0.001**
HbA1c	6.40±1.77	5.53±0.66	0.001**
SBP (mmHg)	139.0±101.8	119.0±12.5	0.036**
DBP (mmHg)	77.7±10.6	73.9±9.29	0.001**
Creatinine	66.7±18.7	63.8±17.4	0.014**
LDL	2.85±0.79	2.98±0.87	0.474
HDL	1.15±0.33	1.40±0.43	0.001**
Triglyceride	1.41±0.74	1.19±0.83	0.135
Cholesterol	4.61±1.11	4.72±1.22	0.575

§P value has been calculated using paired sample t-test; **significant at p<0.05 level

Table 3: Weight loss comparison between age and gender following sleeve gastrectomy (n=141).

Factor	% EWL	P value§	%TWL	P value§
Age group (years)				
≤35	61.6±32.1	0.360	26.8±13.7	0.208
>35	57.3±22.8		24.2±10.6	
Gender				
Male	63.1±31.7	0.315	27.2±13.7	0.279
Female	57.9±25.9		24.8±11.5	

§P value has been calculated using independent sample t-test

Figure 1 depicts that the prevalence of patients with weight regain was 2.1%, while the rest had weight loss (97.9%).

Measuring the relationship between the outcome among age and gender found that no significant relationships were observed between the outcome in terms of age group (p=0.609) and gender (p=1.000) (Table 4).

When exploring the relationship between post-BMI according to age group and gender, we found that there was no significant relationship observed between post-BMI among age group (p=0.083) and gender (p=0.181) (Table 5).

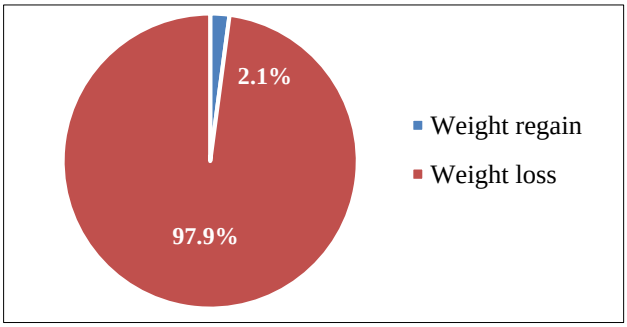

Figure 1: Outcome of sleeve gastrectomy 1-year postoperatively.

Table 4: Relationship between age and gender in terms of outcome (n=141).

Factors	Outcome, N (%)		P value§
	Weight regain (n=03)	Weight loss (n=138)	
Age group (years)			
≤35	02 (66.7)	66 (47.8)	0.609
>35	01 (33.3)	72 (52.2)	
Gender			
Male	01 (33.3)	40 (29.0)	1.000
Female	02 (66.7)	98 (71.0)	

§P value has been calculated using Fischer exact test

Table 5: Relationship between age and gender in terms of post-BMI (n=127).

Factors	Post-BMI, N (%)		P value§
	BMI <30 kg/m^2 (n=37)	BMI ≥30 kg/m^2 (n=90)	
Age group (years)			
≤35	22 (59.5)	38 (42.2)	0.083
>35	15 (40.5)	52 (57.8)	
Gender			
Male	13 (35.1)	20 (22.2)	0.181
Female	24 (64.9)	70 (77.8)	

§P value has been calculated using Fischer exact test

DISCUSSION

This study examined the long-term outcomes of sleeve gastrectomy, focusing on weight regain and failure of losing weight among patients who underwent the procedure between 2018 and 2023 at PSMMC, Riyadh, Saudi Arabia. The findings are particularly relevant given the increasing prevalence of obesity and the corresponding rise in bariatric surgeries worldwide. Sleeve gastrectomy is widely regarded as an effective weight loss procedure, but its long-term efficacy, particularly concerning on weight gain and inability to lose weight after the surgery, requires further exploration.[15,16]

Our study revealed that only 2.1% of patients experienced weight regain one year after surgery, while 97.9% of patients continued to maintain weight loss. This low rate of weight relapse aligns with previous research, which has consistently shown that SG is highly effective in the short to medium term for weight loss. In addition to that, all patients who are planned for SG in PSMMC are enrolled in a diet program and are evaluated and followed by a professional dietician along with psychiatric evaluation to ensure better outcomes, and that might have played a role in those patients maintaining weight after such procedure.[17,18] However, the long-term efficacy remains a subject of debate, with some studies suggesting that up to 30% of patients may experience significant gain of weight within five years post-surgery.[19,20] In a cross-sectional study involving 300 patients who underwent Roux-en-Y gastric bypass (RYGB) from a single institution in the USA and provided preoperative weight and subsequent weights over postoperative years, it was found that 37% experienced significant weight loss relapse, defined as a 25% or greater increase from their lowest post-operative weight (nadir), within 7 years of follow-up.[21] A systematic review of patients who underwent SG indicated that up to 76% experienced significant weight rebound within 6 years post-surgery.[22] In one of the largest prospective cohort studies involving 1,406 RYGB patients at least 2 years post-SG, the average percentage of weight regain from the nadir weight was observed to be 5.7% at one year, increasing progressively to 10.1% at two years, 12.9% at three years, 14.2% at four years, and 15% at five years post-surgery. This data highlights that the most substantial weight relapse tends to occur within the first two years after reaching nadir weight, although it continues to increase up to five years post-operatively. Additionally, the incidence of a 10% or greater weight gain in this cohort was 23% after one year, escalating to 51%, 64%, 69%, and 72% after two, three, four, and five years, respectively.[23] The variability in reported weight gaining rates across studies may be attributed to differences in patient populations, follow-up durations, and definitions of weight regain.

Interestingly, our study found no significant relationship between increased weight and demographic factors such as age and gender. This suggests that other factors, possibly including behavioral, psychological, and metabolic aspects, may play a more crucial role in determining long-term success after sleeve gastrectomy. Previous two reviews have highlighted the importance of lifestyle modifications, including diet and physical activity, in maintaining weight loss after bariatric surgery.[24,25] Patients who do not adhere to these modifications are more likely to experience gain in weight again, regardless of demographic characteristics.[26,27]

The study also assessed changes in metabolic parameters before and after sleeve gastrectomy. Significant improvements were observed in several key parameters, including BMI, HbA1c, SBP, DBP, creatinine, and HDL. These findings are consistent with the established benefits of sleeve gastrectomy in improving metabolic health as reported in a study by Ji et al, in their review which showed significant endocrine function improvement after the surgery associated with improvement in patient's health including the role of fibroblast growth factors 19 and 21, glucagon-like peptide-1, and pancreatic peptide YY.[28] The same was reported in a retrospective study conducted in teaching and nonteaching hospitals in Michigan, USA which showed significant improvement in BMI outcomes specifically among those who are older, diabetics, hypertensive, and have hyperlipidemia.[29] For instance, the reduction in HbA1c levels reflects better glycemic control, which is particularly important for patients with type 2 diabetes.[30,31] The improvements in blood pressure parameters (SBP and DBP) further underscore the cardiovascular benefits of the procedure.[32]

However, no significant changes were observed in LDL, triglyceride, and cholesterol levels, which in agreement with an observational, retrospective study of analytical cohorts enrolling 100 patients distributed into two groups undergone gastric bypass (GBP) surgery and SG surgery, conducted by Garay et al in Spain which showed no significant difference in TC or LDL among those underwent SG surgery however, a significant improvement was reported in patients underwent GBP after 60 months.[33] However, these results contrast a previous retrospective study among Forty-six patients treated with laparoscopic sleeve gastrectomy which showed a significant reduction in LDL, triglyceride, and cholesterol levels after 18 months after surgery.[34] The lack of significant change in these parameters in our study could be due to the relatively short follow-up period or the baseline characteristics of our patient population. It is also possible that the lipid-lowering effects of sleeve gastrectomy may manifest over a more extended period, necessitating longer follow-up studies.

The comparison of weight loss outcomes between different age groups and genders revealed no significant differences in both % excess weight loss (% EWL) and % total weight loss (% TWL). This finding is noteworthy as it suggests that sleeve gastrectomy is equally effective across different demographic groups, supporting its use as a universal treatment for obesity. However, a previous review showed Weight loss after metabolic/bariatric surgery is influenced by many clinical variables, including initial body mass index, age, gender, ethnicity, and type of surgery.[34] In addition, a previous multi-center matched case-control study among Eighty-nine patients older than 60 years, who underwent SG in Poland, reported better outcomes in younger patients or females.[35] However, the lack of significant differences in our study could indicate that factors such as preoperative BMI, comorbidities, and postoperative adherence to dietary and physical activity recommendations may have a more substantial impact on weight loss outcomes than age or gender alone.

Postoperative BMI (post-BMI) was analyzed to assess the effectiveness of sleeve gastrectomy in achieving a BMI below 30 kg/m^2, which is often considered a target for reducing obesity-related health risks. Our results showed that there was no significant relationship between post-BMI and age or gender. This outcome aligns with the findings related to % EWL and % TWL, further indicating that sleeve gastrectomy's effectiveness is not significantly influenced by these demographic factors as reported in two previous reviews.[36,37] It also highlights the need for individualized patient management, focusing on modifiable risk factors rather than relying on demographic predictors alone.

Limitations

Several limitations exist in this study that must be acknowledged when interpreting the findings. Firstly, the retrospective design entails using patient records of past events which may bias and limit any causal inference. Again, five years may not capture adequately the long-term outcomes beyond this period leading to an assessment of sustained weight loss and complications that might be flawed. Secondly, because it was conducted at a single institution, it is possible that the sample used in this study did not represent all patients who underwent sleeve gastrectomy elsewhere. Plus, behavior factors such as diet adherence and physical activity were not included in data gathering hence making it difficult for one to fully weigh their contribution towards the regaining of body mass lost during the preceding operation. Another issue is how some surgical procedures were performed differently on each patient and different post-surgery care was offered; therefore, these could impact how generalizable these results are. It would be important to consider these aspects of study design in future work so as to have a more complete understanding about how well sleeve gastrectomy works overtime.

CONCLUSION

This study examined the long-term outcomes of sleeve gastrectomy in a cohort of 141 patients. The results indicate that sleeve gastrectomy is an effective surgical intervention for achieving significant and sustained improvements in various metabolic parameters. Specifically, there were notable post-operative reductions in mean BMI, HbA1c, blood pressure, creatinine, and HDL levels. However, no significant changes were observed for LDL, triglycerides, and total cholesterol. Importantly, the degree of weight loss, as measured by percent excess weight loss and percent total weight loss, did not differ significantly based on patient age or gender. Additionally, there were no significant relationships between post-operative BMI and either age or gender. These findings suggest that sleeve gastrectomy can lead to substantial and durable metabolic benefits irrespective of patient demographic factors. The consistent improvements across the studied population underscore the utility of this surgical approach for effectively managing obesity and associated metabolic disorders. Further long-term research is warranted to continue evaluating the sustainability of these outcomes. Overall, this study provides valuable insights into the real-world effectiveness of sleeve gastrectomy as a treatment for severe obesity.

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