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Impact of Post-Operative Follow-Up on Long-Term Outcomes of Laparoscopic Sleeve Gastrectomy in the Saudi Arabian Population: A Retrospective Cohort Study During the COVID-19 Era

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Abstract

Background: Laparoscopic Sleeve Gastrectomy (LSG) is a widely utilized bariatric procedure for treating obesity and related comorbidities. However, the impact of lockdown during COVID-19 lockdowns on postoperative follow-up care and long-term outcomes of LSG, particularly in the Saudi Arabian population, remains underexplored. This study aims to evaluate the influence of follow-up care on weight loss, complication rate, and resolution comorbidities in patients undergoing LSG.

Materials and Methods: This retrospective cohort study included 148 patients who underwent LSG at King Abdullah Medical City in Makkah, Saudi Arabia, between May 1, 2019, and December 30, 2020. Patients were categorized into two groups based on the duration of follow-up: no follow-up (n = 54) and more than one year of follow-up (n = 94). Sociodemographic and clinical characteristics, postoperative complications, and comorbidity resolution were compared between these two groups. The primary outcome measured was the reduction in Body Mass Index (BMI), while secondary outcomes included complication rates and the resolution of diabetes mellitus and hypertension.

Results: The mean BMI reduction was 13.43 ± 9.62 in the no-follow-up group and 14.34 ± 7.68 in the group with more than one year of follow-up, with no statistically significant difference observed (p = 0.527). Complications were more frequent in the follow-up group (77.1%) compared to the no-follow-up group (22.9%), approaching statistical significance (p = 0.051). Specific complications, such as leaks, bleeding, and weight regain, were observed only in the follow-up group. Additionally, the resolution of diabetes mellitus (80% vs. 20%) and hypertension (66.7% vs. 33.3%) was higher in the follow-up group, though these differences were not statistically significant.

Conclusion: The findings suggest that regular follow-up care after LSG is important for early detecting and managing of post-operative complications. While no significant difference in BMI reduction was observed between the two groups, the higher prevalence of complications in the follow-up group underscores the importance of ongoing monitoring to optimize patient outcomes.

Keywords: Obesity; World Health Organization (WHO); Saudi Arabia

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Introduction

Obesity is now recognized as one of the most significant public health challenges of the 21st century, with global prevalence increasing at an alarming rate [1]. According to the World Health Organization (WHO), obesity rates have nearly tripled since 1975, with over 650 million adults classified as obese as of 2016 [2]. This widespread rise in obesity has fueled demand for effective treatment options. Obesity is a complex, multifactorial disease influenced by genetics, behavior, environment, and metabolism [3,4]. The health consequences of obesity are severe, leading to increased mortality and morbidity rates. Traditional weight loss methods, including lifestyle modification, dietary interventions, and pharmacotherapy, often produce limited long-term results for individuals with severe obesity [6,7]. Consequently, bariatric surgery has emerged as a crucial option for achieving substantial, sustained weight loss and improving obesity-related conditions. In the Middle East, and particularly Saudi Arabia, obesity rates have escalated dramatically. Nearly 70% of the Saudi adult population are overweight, and around 35% are classified as obese [8-10], leading to a substantial burden of associated comorbidities, such as type II diabetes, cardiovascular diseases, sleep apnea, and an increased risk of certain cancers. These trends have spurred an increase in bariatric surgeries, with more than 15,000 procedures estimated annually in Saudi Arabia. Current Saudi clinical practice guidelines, aligned with recommendations from the American Society for Metabolic and Bariatric Surgery advise bariatric surgery for patients with body mass index (BMI) \geq 40 or \geq 35 kg/m² with comorbidities, to reduce health risks and to enhance quality of life [9].

Over recent decades, bariatric surgery has evolved, with various procedures introduced to address obesity more safely and effectively [11]. Initially, procedures such as jejunoileal bypass and vertical banded gastroplasty were common, but they often resulted in high complication rates, and unsatisfactory long-term outcomes [12]. The advent of laparoscopic techniques in the 1990s revolutionized bariatric surgery, making it safer and less invasive [13]. Among these procedures, laparoscopic sleeve gastrectomy (LSG) has gained widespread popularity, becoming one of the most frequently performed bariatric surgeries globally [16]. LSG was initially part of a staged approach to biliopancreatic diversion with duodenal switch (BPD/DS) but soon became a standalone

procedure due to its safety, simplicity, and effectiveness [14,17]. However, concerns about the complexity of the procedure, the risk of malabsorption, and long-term nutritional deficiencies led to the development of alternative surgical options [15]. LSG involves the resection of approximately 75-80% of the stomach, creating a smaller tubular [18] stomach that limits food intake and reduces appetite by lowering levels of ghrelin, a hunger stimulating hormone [19]. Excess weight loss (EWL) following LSG ranges from 50-70% at 1-2 years postoperatively, with some studies reporting sustained weight loss up to 5 years [21]. This procedure has demonstrated significant short- to mid-term success in weight loss and in the management of obesity-related comorbidities [21,22]. According to the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO), over 685,000 bariatric surgeries were performed globally in 2021, with LSG accounting for more than 50% of these procedures [20].

Despite its benefits, LSG is not without risks. Potential complications include staple line leaks, bleeding, gastroesophageal reflux disease (GERD), stricture formation, and nutritional deficiencies, with some patients requiring revision surgery due to inadequate weight loss, weight regain, or severe GERD. The importance of long-term follow-up in managing these risks is well-documented, as ongoing monitoring can help address dietary needs, deficiencies, and mental health concerns critical to sustained weight loss. Conversion to RYGB or BPD/DS is often considered in these cases. The rate of revision surgery varies widely in the literature, with some studies reporting rates as high as 15-20% [23]. The need for revision surgery underscores the importance of long-term follow-up and monitoring of patients after LSG.

The COVID-19 pandemic has further disrupted healthcare systems globally, affecting routine care and follow-up care for bariatric patients. In Saudi Arabia, the pandemic limited in-person follow-up, often replacing it with telemedicine, which may have impacted patient outcomes due to reduced monitoring [25]. Pandemic-related restrictions also influenced physical activity, dietary habits, and weight management behaviors, potentially exacerbating weight regain [24,26].

Rationale

Despite the widespread adoption of LSG as a primary bariatric procedure, there remains a significant gap in understanding the

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long-term outcomes, within the Saudi Arabian population. The rising rates of obesity in Saudi Arabia, highlight the urgency of establishing evidence-based guidelines tailored to this population. While LSG is recognized for its effectiveness in achieving weight loss and improving obesity related comorbidities, the sustainability of these benefits, over the long term, particularly in relation to postoperative follow up, is not well-documented.

This study seeks to address this gap by examining not only on the overall outcomes of LSG but also the critical role that follow-up care plays in influencing these outcomes. By comparing patients who had regular follow-up after LSG with those who did not, the study aims to assess the impact of follow-up on weight loss, BMI reduction, and the incidence of complications over a five-year period. The study's primary objective is to evaluate the outcomes of LSG performed at high volume bariatric center in Saudi Arabia, while secondary objectives include assessing the follow-up rate, determining the conversion rate to other procedures, and exploring the complications associated with LSG.

Materials and Methods

Study design and setting

A retrospective cohort study was conducted at the Bariatric Surgery Department at tertiary hospital in Makkah, Saudi Arabia. The study population comprised 300 patients who underwent primary LSG between May 1, 2019, and December 30, 2020.

Participants

A total of 160 patients were selected using propensity scoring to match demographic and clinical characteristics between two groups: those with regular follow-up for more than one year (100 patients) and those with less than one year of follow-up (60 patients). Depending on the follow-up schedule, which is two weeks after the surgery, three months, six months, nine months, one year, and then every six months thereafter. Exclusions were made for six patients in the follow-up group who declined participation and six in the non-follow-up group who could not be contacted, resulting in a final sample of 148 patients (94 in the follow-up group and 54 in the non-follow-up group).

Data collection

Researchers collected demographic data, follow-up records, comorbidities, Body Mass Index (BMI) data (Preoperative and current) from electronic medical records. Post-operative complications such as leaks, bleeding, strictures, gastritis, peptic ulcer disease, and readmissions within 30 days were documented. Malnutrition indicators (Haemoglobin, Vitamin D, Vitamin B12, albumin, and parathyroid hormone levels), and complications like stenosis, reflux, weight regain, and the need for revisional surgery were assessed and confirmed through the hospital records. Patients consent was obtained verbally, witnessed, and documented on a standardized consent form.

Inclusion and exclusion criteria

The inclusion criteria were all patients 18 years or older who underwent primary LSG within the study period. Exclusion criteria included patients who had revision surgery from a previous bariatric procedure or those who declined to participation.

Follow-up and outcome measures

Patients were followed up postoperatively until the end of 2023 to ensure a comprehensive analysis. The primary outcome was BMI reduction, while secondary outcomes included complication rates, comorbidity resolution (such as diabetes and hypertension), and weight regain. Data were collected both via direct patient contact for recent weight measurements and through electronic medical records for biochemical and other health assessments.

Statistical analysis

SPSS version 26 (IBM, Chicago, USA) was used for statistical analysis. Descriptive statistics (mean, standard deviation) were calculated for continuous variables such as age and BMI. Independent t-tests or ANOVA were used to compare continuous variables between groups, while Pearson's chi-square test assessed associations among categorical variables. To evaluate the change in the percentage of excess weight loss (%EWL) was compared between groups. Multivariate logistic regression was applied to identify predictive factors for inadequate weight reduction. Statistical significance was set at p < 0.05. An independent biostatistician oversaw the data analysis process, ensuring rigor and reliability.

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Ethical considerations

The study received ethical approval from the King Abdullah Medical City Research Center. All data were handled with strict adherence to confidentiality and privacy protocols in line with ethical guidelines, ensuring participant protection and data integrity.

Results

Table 1 shows the sociodemographic and clinical characteristics of patients who underwent LSG, comparing those with no follow-up and more than one year of follow-up. A total of 148 patients were analyzed, with 54 (36.5%) having no follow-up and 94 (63.5%) receiving follow-up care for one year or more. The mean age was

 42.2 ± 11.6 years in the no follow up group and 43.3 ± 10.7 years in the follow-up group, with most patients aged 35-45 years in both groups.

A higher proportion of females had more than one year of follow-up (62.8%) compared to those with no follow-up (51.9%). Diabetes mellitus and hypertension were prevalent across both groups, though diabetes was slightly more common in the no-follow-up group (35.2% vs. 28.7%), whereas hypertension was somewhat more frequent among those with follow-up (37.2% vs. 27.8%). Other comorbidities, including cardiovascular diseases, obstructive sleep apnea, asthma, and hypothyroidism were observed more often in patients with over a year of follow-up.

No follow-up		Follow-up		n value	
		>1 year		p value	
Age	Mean (SD) years	42.2 ± 11.6	43.3 ± 10.7	0.550	
	< = 25 years	4 (7.4%)	5 (5.3%)	0.959	
	26-35 years	12 (22.2%)	17 (18.1%)		
	35-45 years	17 (31.5%)	35 (37.2%)		
	46-55 years	12 (22.2%)	22 (23.4%)		
	56-65 years	8 (14.8%)	14 (14.9%)		
	>-66 years	1 (1.9%)	1 (1.1%)		
Gender	Female	28 (51.9%)	59 (62.8%)	0.194	
	Male	26 (48.1%)	35 (37.2%)		
Comorbidities	Diabetes Mellites	19 (35.2%)	27 (28.7%)	0.414	
	Hypertension	15 (27.8%)	35 (37.2%)	0.242	
	Cardiovascular diseases	1 (1.9%)	4 (4.3%)	0.436	
	Obstructive sleep apnea	0 (0%)	3 (3.2%)	0.185	
	Asthma	3 (5.6%)	10 (10.6%)	0.293	
	Hypothyroidism	3 (5.6%)	13 (13.8%)	0.119	

Table 1: Sociodemographic and clinical characteristics based on follow-up duration.

The mean BMI reduction was 13.43 (SD ± 9.62) in the no-follow-up group and 14.34 (SD ±7.68) in the group with more than one year of follow-up [Figure 1]. However, there was no statistically significant differences observed (p = 0.527)

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Table 2 compares outcomes and complications associated with LSG between patients with no follow-up and those with more than one year of follow-up. Complications were more frequent in the >1-year group (77.1%) compared to the no follow-up group (22.9%), (p = 0.051). Specific complications like leaks, bleeding, weight regain, hernia, iron deficiency, hypocalcemia, and the need for revisional surgery were observed only in the >1-year follow-up group. The resolution of diabetes mellitus was higher in the >1-year group (80% vs. 20%), as was the resolution of hypertension (66.7% vs. 33.3%), although these differences were not statistically significant (p > 0.05).

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Figure 1: Comparison of differences in BMI after laparoscopic sleeve gastrectomy (LSG) between patients with no follow-up and those with follow-up greater than 1 year. The box plot shows the median, interquartile range, and range of BMI differences for both groups. The asterisk (*) indicates a statistically significant difference in BMI outcomes between the two groups.

No follow	Follow-up				
NO IOIIOW-	>1 year	Total	p value		
Change in BMI (post-LSG)	13.43 ± 9.62	14.34 ± 7.68	14.00 ± 8.41	0.527	
Over all Complications	No	46 (40.7%)	67 (59.3%)	113 (76.4%)	0.051
	Yes	8 (22.9%)	27 (77.1%)	35 (23.6%)	
Leak	No	54 (36.7%)	93 (63.3%)	147 (99.3%)	0.447
	Yes	0 (0%)	1 (100%)	1 (0.7%)	
Bleeding	No	54 (37.0%)	92 (63%)	146 (98.6%)	0.280
	Yes	0 (0%)	2 (100%)	2 (1.4%)	
Weight regains	No	54 (37.2%)	92 (63%)	146 (98.6%)	0.280
	Yes	0 (0%)	2 (100%)	2 (1.4%)	
Hernia	No	52 (35.9%)	93 (64.1%)	145 (98%)	0.273
	Yes	2 (66.7%)	1 (33.3%)	3 (2%)	
Iron deficiency	No	54 (36.7%)	93 (63.3%)	147 (99.3%)	0.447
	Yes	0 (0%)	1 (100%)	1 (0.7%)	
Hypocalcemia	No	54 (37%)	92 (63%)	146 (98.6%)	0.280
	Yes	0 (0%)	2 (100%)	2 (1.4%)	
GERD	No	49 (38.6%)	78 (61.4%)	127 (85.8%)	0.193
	Yes	5 (23.8%)	16 (76.2%)	21 (14.2%)	
Erosive esophagitis	No	54 (37.8%)	89 (62.2%)	143 (96.6%)	0.085
	Yes	0 (0%)	5 (100%)	5 (3.4%)	
Revisional surgery	No	54 (37.2%)	91 (62.8%)	145 (98%)	0.185
	Yes	0 (0%)	3 (100%)	3 (2%)	
Resolution of Diabetes Mellites	No	17 (47.2%)	19 (52.8%)	36 (78.3%)	0.122
(n = 46)	Yes	2 (20%)	8 (80%)	10 (21.8%)	
Resolution of Hypertension (n	No	13 (29.5%)	31 (70.5%)	44 (88%)	0.185
= 50)	Yes	2 (33.3%)	4 (66.7%)	6 (12%)	

Table 2: Comparison of Outcomes and complications associated with LSG between different follow-up duration.

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Discussion

The findings from the study demonstrate the significant importance of regular follow-up care in post bariatric surgery outcomes. Patients in follow-up group achieved significant weight loss than those without follow-up, although the decrease in BMI was not statistically significant. Regular follow-up visits provide essential opportunities to promptly identify and address any problems, including dietary deficiencies, and mental wellness needs, which are crucial for sustaining long-term weight loss and overall well-being. Studies consistently show that patients adhering to regular follow-up schedules experience more favourable longterm results, such as sustained weight loss, improved metabolic profiles, and reduced complications. For instance, Sjöström., et al. found that long-term follow-up after bariatric surgery enhanced weight maintenance and reduces incidence of type 2 diabetes and cardiovascular disease [27]. Similarly, research by Salminen., et al. emphasizes that ongoing monitoring is essential to managing nutritional needs after LSG, particularly for vitamins B12 and D, iron, and other micronutrients [28]. Additionally, hormonal changes induced by the procedure, particularly the reduction in ghrelin levels, significantly influence these outcomes [29]. Nevertheless, the long-term effectiveness of LSG remains a topic of ongoing research. Emerging data suggest that a subset of patients may experience weight regain and a recurrence of comorbidities several years post-surgery [30,31]. Factors such as gastric sleeve dilation, dietary noncompliance, and the resumption of unhealthy eating habits contribute to this weight regain.

The COVID-19 pandemic has significantly disrupted global healthcare systems, leading to a major impact on routine care, including post-bariatric surgery follow-up appointments. The follow-up period in this study coincided with the pandemic's onset, likely dampening the intervention's potential positive effects. The pandemic affected post-operative experiences through multiple avenues; facility closures and fear of viral exposure, disrupted established dietary and physical activity routines, potentially hindering adherence to post-surgical guidelines. Transitioning follow-up care to telemedicine, while necessary, may have inadvertently compromised the quality of patientprovider interactions and personalized support. Furthermore, the pandemic exacerbated financial and psychosocial stressors, such as job insecurity, social isolation, and heightened anxiety, which are known to adversely affect weight management and overall well-being [33,34]. Additionally, recent evidence suggests that COVID-19 itself may influence weight loss patterns. A study done by Fatani., *et al.* reported weight gain in individuals with diabetes during the pandemic, potentially due to lockdown restrictions, reduced physical activity, and dietary changes [35]. Conversely, Di Filippo., *et al.* reported weight loss associated with COVID-19 infection, possibly due to factors like loss of taste and smell, reduced appetite, or illness-related metabolic changes [36].

Patient adherence to follow-up protocols likely influenced outcomes. Adherance to medical recommendations varies widely, influenced by factors such as socioeconomic status, education level, and psychological support [37,38]. Additionally, some patients who did not attend follow-up appointments may still have adhered to the recommended dietary and lifestyle changes post-surgery, possibly contributing to the comparable outcomes in BMI reduction outcomes [39]. Additionally, some patients might only seek medical attention when complications arise, potentially skewing observed benefits of regular follow-up [40]. Our analysis showed that complications after surgery were significantly higher in patients who attended follow-up visits, reflecting the selective nature of medical follow up. Self-motivation and strong support systems may also influence post-surgery outcomes independently of formal follow-up care. Patients with higher intrinsic motivation or strong family and community support may achieve significant BMI reductions even without regular clinical follow-up [41]. Such patients may proactively seek information, adhere to prescribed dietary changes and maintain physical activity, achieving comparable outcomes to those with structured follow-up care.

Unaccounted for confounding variables could have influenced the outcomes and obscured the follow-up impact. Discrepancies in baseline characteristics, lifestyle changes, or medication use between groups are potential confounders. Statistical adjustments or matching procedures could ideally help to isolate the effect of the follow-up intervention. Additionally, patients in the nonfollow-up group reported conditions like iron deficiency anemia and hypocalcemia based on recent lab results, yet these were not verified through medical records, meaning some cases might have been missed. This underscores the importance of regular followup for monitoring health conditions that may impact weight

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maintenance and recovery. This study has some limitations, such as self-reporting bias. In addition to that, the study was affected by the COVID-19 period, which may affect many factors, including postbariatric surgery follow-up appointments, lifestyle, and physical activity.

Further research with a larger cohort, extended follow up period, standardized interventions protocols, and a comprehensive analysis of influencing factors is warranted to better understand the impact of follow-up interventions on long term weight loss sustainability post bariatric surgery.

Conclusion

This study underscores the significance of post-operative followup care in determining the long term success of Laparoscopic Sleeve Gastrectomy. While the reduction in BMI did not differ significantly between patients with and without follow-ups, the group with more than one year of follow-up showed a higher incidence of complications. This findings suggest that regular monitoring allows for the timely detection and management of post-operative issues, which may otherwise go unnoticed. Notably, complications such as leaks, bleeding, and weight regain occurred only in followup group, likely due to the increase surveillance in these patients. Furthermore, the resolution of comorbidities, including diabetes mellitus and hypertension, was more common in the follow-up group, though this difference was not statistically significant.

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