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Pre- and Postoperative Evaluation of the Changes in Anthropometric Parameters on Female Laparoscopic Sleeve Gastrectomy Patients: A Cross-Sectional Follow-Up Study

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Background/Aims: Obesity is a major global health issue, exacerbated by reduced physical activity due to technological advancements. Bariatric surgery is the most effective treatment for significant weight loss. This study examines 2-month postoperative changes in anthropometric parameters, muscle strength, and regional fat reduction in female patients.
Materials and Methods: In this observational prospective study, anthropometric measurements were collected from female patients who underwent laparoscopic sleeve gastrectomy between October 2022 and March 2023. Data were recorded preoperatively and at the first and second months postsurgery.
Results: A significant reduction in skinfold thickness, indicative of fat mass reduction, was observed, alongside a marked improvement in grip strength within the 8-week postoperative period.
Conclusion: This study is notable for being the first to comprehensively evaluate short-term changes in skinfold thickness following bariatric surgery. In addition, it is pioneering in its application of the pinch strength test alongside the hand grip strength test in this context.

Keywords: bariatric surgery, laparoscopic sleeve gastrectomy, anthropometric measurements, skinfold thickness, grip strength

Introduction

Obesity is a major global health issue, driven partly by reduced physical activity due to technological advancements such as automation and computerization.[1,2] It imposes significant financial burdens on health care systems.[3] According to the World Health Organization, obesity rates are increasing globally, with over 1 billion people—equivalent to one in eight individuals—affected by obesity. A review published in The Lancet revealed that adult obesity worldwide has doubled between 1990 and 2022, while obesity among adolescents has surged fourfold.[1,2] Looking at the data for Türkiye, as of 2008, the prevalence of obesity in the general population is 27.8%, with a rate of 34.0% among women and 21.7% among men.[4]

Obesity increases the risk of insulin resistance, type II diabetes, hypertension, dyslipidemia, sleep apnea, cardiovascular diseases,[5,6] and cancer.[7] It affects the sympathetic nervous system,[8,9] contributes to musculoskeletal issues, gallbladder disease, nonalcoholic fatty liver disease, pulmonary dysfunction,[10] and is linked to a sedentary lifestyle, reduced cardiopulmonary fitness,[11] and lower life expectancy.[12]

Bariatric surgery is an effective treatment for significant, long-term weight loss and preventing obesity-related

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complications. The estimate weight loss after sleeve gastrectomy ranged between 60% and 80% of the excess weight, around 35–40% of total body weight.[13,14] It provides substantial benefits with minimal complications for most morbidly obese patients.[15] Typically considered after the failure of nonsurgical methods such as diet, exercise, and medications, it also improves obesity-related comorbidities and modifies fasting and satiety patterns.[16]

Laparoscopic sleeve gastrectomy (LSG) is a widely accepted bariatric procedure that involves removal of a portion of the stomach, leaving a tubular stomach.[17] The incision starts 4–5 cm from the pylorus and extends to the angle of His. LSG has proven to be effective for weight loss. Thanks to its relative technical simplicity and long-term data supporting its durability in treating obesity and related comorbidities, sleeve gastrectomy has become increasingly popular among both patients and surgeons. Although there are some variations in the technical approach to performing a LSG certain key steps must be followed to ensure safe and successful outcomes.[18]

Skinfold thickness is a simple, cost-effective method to estimate body fat, assuming subcutaneous fat reflects total body fat proportion. Measurements using a caliper provide an alternative to weight and height-based metrics.[19,20]

Postoperative follow-up is essential for reducing weight regain and ensuring patient safety after bariatric surgery. A primary goal is to reduce body fat while preserving lean body mass (LBM), particularly body cell mass—a critical LBM subset vital for maintaining metabolic and physical functions.[21]

Postbariatric monitoring of weight, muscle and fat loss, muscle strength, and body fat distribution is crucial for surgeons and dietitians. This study aims to examine short-term (2-month) changes in anthropometric parameters among female patients, assess weight loss effects on muscle strength, and quantify regional fat reduction postsurgery.

Materials and Methods

Study design

This prospective cross-sectional study included 26 female patients who underwent LSG at Kırşehir Training and Research Hospital between October 2022 and March 2023. These patients, eligible for bariatric surgery due to unsuccessful weight loss despite lifestyle and pharmacological interventions, had their demographic and anthropometric data collected before the procedure.

All patients followed a standardized postoperative nutritional plan, starting with a 15-day liquid diet, progressing to pureed, and eventually solid foods, with a recommended daily intake of 400–500 kcal to ensure weight loss. Considering their tolerance to diet in the follow-up, they were placed on a strict diet after the 15th day and protein intake was planned as 0.8–1.2 g/kg/body weight per day. Anthropometric assessments were performed at baseline and during the first and second postoperative months. Two patients missing follow-up data were excluded from the final analysis. The study received ethical approval from the Kırşehir Ahi Evran University Medical Research Ethics Committee (decision number 2022-09/97). Informed consent was obtained from all participants.

Anthropometric measurements

The data collection process was conducted 1–3 days before surgery and during the first and second postoperative months. Demographic information was collected via a structured questionnaire, and 11 anthropometric measurements were taken from nine anatomical sites using a skinfold caliper, including vertical and horizontal abdominal skinfold thickness (ASFv, ASFh), triceps (TSF), biceps (BSF), chest (CSF), vertical and horizontal midaxillary skinfold thickness (MSFv, MSFh), subscapular (SSSF), thigh (ThSF), suprailiac (SISF), and medial calf (MCSF). Pinch strength measurements—tip pinch (TP), key pinch (KP), and Palmar pinch (PP)—and circumferential measurements—waist (WC), hip (HC), and neck circumference (NC)—were recorded, alongside hand grip strength (HGS), totaling 18 measurement points.

Pinch strength was measured using a digital pinch meter with participants positioned as follows: shoulders adducted, elbows flexed at 90°, forearms in neutral, and wrists at 0–30° dorsiflexion and 0–15° ulnar deviation. The highest recorded value for each hand was used for analysis.[22] Circumferential measurements were taken in centimeters with a nonstretchable tape. WC was measured at the umbilicus, HC at the widest hip part, and NC at the midpoint between the middle cervical spine and anterior neck. The waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR) were calculated from these measurements.

HGS was assessed using a digital dynamometer with the participant standing, and measurements were taken from the dominant hand. Central obesity indices derived from WC, such as the conicity index (CI) and a-body shape index (ABSI), were included. CI incorporates WC, height, and weight to analyze fat distribution, while ABSI, based on WC, is largely independent of height, weight, and body mass index (BMI).[23]

CI was calculated as follows:

$$\mathrm{CI} = \frac{\mathrm{WC\,(m)}}{0.109 \times \sqrt{\mathrm{weight\,(kg)} / \mathrm{height\,(m)}}}$$

ABSI was calculated as follows:

$$\mathrm{ABSI} = \frac{\mathrm{WC\,(m)}}{\mathrm{BMI}^{\frac{2}{3}} \times \mathrm{height\,(m)}^{\frac{1}{2}}}$$

All measurements were performed twice by the same person in the research group, and the highest values measured for grip strength and pinch forces were recorded.

Statistical analysis

Statistical analysis of the study data was performed using SPSS version 29.0 software for Windows (IBM SPSS Statistics for Windows, Version 29.0. Armonk, NY: IBM Corp., USA). The sample size calculation was performed using the G*Power 3.1.9.6 software. The Shapiro–Wilk test was used to examine the normality of the quantitative continuous variables. Descriptive statistics were presented using mean ± SD, median (minimum–maximum), where appropriate. Wilcoxon signed-rank test was used for pairwise comparisons between preoperative and postoperative measurements. Differences in the anthropometric parameters readings in were compared using repeated measures analysis of variance (if normality and sphericity assumptions were satisfied); otherwise, the Friedman test was used. Pairwise comparisons were conducted using the Bonferroni multiple comparison test (if assumptions were satisfied), otherwise the Wilcoxon signed-rank test was used. Prior to the study, *a priori* power analysis was conducted to determine the required sample size. Based on the analysis, with an effect size of f = 0.30, $\alpha = 0.05$, power ($1-\beta$ err prob) = 0.80, number of groups = 1, number of measurements = 3, correlation among repeated measures = 0.5, and nonsphericity correction $\varepsilon = 1$, the minimum required total sample size was calculated to be 20.

A value of $p < 0.05$ was accepted as statistically significant.

Results

Measurements were conducted preoperatively and at 1 and 2 months postoperatively, assessing ASFv, ASFh, TSF, BSF, CSF, MSFv, MSFh, SSSF, ThSF, SISF, MCSF, TP, KP, PP, HGS, WC, HC, and NC. Descriptive statistics and intergroup comparisons are presented (Table 1). These statistics and comparisons visualized (Fig. 1). Significant improvements were observed postoperatively across most parameters compared to baseline, reflecting the positive impact of the surgical intervention.

Significant reductions were noted in ASFv, ASFh, TSF, BSF, CSF, MSFv, MSFh, SSSF, ThSF, MCSF, SISF, WC, HC, NC, WHtR, WHR, HGS, PP, and KP ($p < 0.05$) (Fig. 1). However, nonsignificant changes were found for ASFv and HGS during the second postoperative period ($p = 0.112$, $p = 1.000$, respectively). KP showed significance only in the first postoperative period, whereas WHR and PP showed changes only in the second postoperative period (Table 1). TP remained nonsignificant across all time points ($p = 0.237$).

Comparisons of ABSI and CI, limited to preoperative and second postoperative measurements, revealed a significant reduction in CI ($p < 0.05$), whereas ABSI showed no significant change. This indicates a stronger response to intervention in CI than ABSI (Table 2).

Discussion

LSG currently represents the most widely performed primary bariatric intervention globally. Its efficacy and safety in achieving favorable anthropometric outcomes are well-established, primarily due to its profound metabolic impact mediated by intricate hormonal pathways. These endocrine alterations significantly influence satiety regulation, glycemic homeostasis, and gastrointestinal functionality, contributing to sustained weight loss and metabolic improvements.[24] In the study by Pizza et al. (2021), LSG patients were prospectively randomized into two groups: group A (with the resection starting 2 cm proximal to the pylorus) and group B (starting 6 cm proximal to the pylorus). All patients were monitored at 3, 6, 12, and 24 months. During the first 12 months, BMI, %excess weight loss, and %total weight loss showed statistically significant differences, favoring group A.[25] From a surgical perspective, LSG is a technically reproducible and time-efficient procedure, as it involves only gastric resection without requiring intestinal anastomosis. However, despite its advantages, LSG is not devoid of

Table 1. Descriptive Statistics and *p* Values of the Measurements ($n = 24$)

Variables	*Preoperative mean ± SD and median (Min–Max)*	*First postoperative mean ± SD and median (Min–Max)*	*Second postoperative mean ± SD and median (Min–Max)*	p
Vertical abdominal skinfold thickness (ASFv) (mm)	33.41 ± 6.17^a	25.87 ± 4.07^b	24.00 ± 4.75^b	0.000*
Horizontal abdominal skinfold thickness (ASFh) (mm)	35.02 ± 5.14^a	26.41 ± 5.03^b	23.85 ± 5.01^c	0.000*
Triceps skinfold thickness (TSF)(mm)	37.45 ± 5.74^a	30.79 ± 3.76^b	26.91 ± 5.01^c	0.000*
Biceps skinfold thickness (BSF) (mm)	24.00 ± 8.51^a	18.25 ± 6.32^b	15.25 ± 5.68^c	0.000*
Chest skinfold thickness (CSF) (mm)	26.83 ± 7.48^a	18.89 ± 6.40^b	15.79 ± 5.80^c	0.000*
Vertical midaxillary skinfold thickness (MSFv) (mm)	28.91 ± 6.50^a	23.02 ± 5.35^b	19.75 ± 5.92^c	0.000*
Horizontal midaxillary skinfold thickness (MSFh) (mm)	33.37 ± 7.63^a	25.66 ± 6.25^b	21.33 ± 5.76^c	0.000*
Subscapular skinfold thickness (SSSF) (mm)	$38.0\ (34.0–47.0)^a$	$30.0\ (21.0–40.0)^b$	$26.0\ (18.0–41.0)^c$	0.000**
Thigh skinfold thickness (ThSF) (mm)	45.08 ± 5.14^a	37.00 ± 6.08^b	34.54 ± 5.15^c	0.000*
Medial calf skinfold thickness (MCSF) (mm)	$42.0\ (18.0–52.0)^a$	$32.5\ (16.0–41.0)^b$	$27.0\ (15.0–39.0)^c$	0.000**
Suprailiac skinfold thickness (SISF) (mm)	$30.0\ (24.0–40.0)^a$	$22.0\ (13.0–30.0)^b$	$18.0\ (13.0–29.0)^c$	0.000**
Tip pinch (TP) (lbs)	5.33 ± 1.31^a	5.15 ± 1.10^a	5.56 ± 1.10^a	0.237*
Key pinch (KP)(lbs)	$7.00\ (3.63–11.29)^{ab}$	$6.44\ (4.72–11.29)^a$	$7.30\ (5.08–11.88)^{ab}$	0.048**
Palmar pinch (PP) (lbs)	5.05 ± 1.33^a	5.56 ± 1.71^a	5.85 ± 1.44^a	0.042*
Hand grip strength (HGS) (kg)	29.27 ± 6.87^a	33.95 ± 6.70^b	34.44 ± 7.09^b	0.000*
Waist circumference (WC) (mm)	123.16 ± 11.72^a	113.41 ± 10.81^b	107.75 ± 11.31^c	0.000*
Hip circumference (HC) (mm)	135.79 ± 8.93^a	126.50 ± 8.45^b	122.04 ± 7.89^c	0.000*
Neck circumference (NC) (mm)	$40.0\ (36.0–50.0)^a$	$37.0\ (34.0–45.0)^b$	$36.0\ (33.0–43.0)^c$	0.000**
Waist-to-hip ratio (WHR) (mm)	0.906 ± 0.056	0.896 ± 0.052	0.882 ± 0.060	0.005*
Waist-to-height ratio (WHtR) (mm)	0.760 ± 0.060^a	0.700 ± 0.056^b	0.665 ± 0.062^c	0.000*

*Repeated measures ANOVA.
**Kruskal–Wallis test.
Means with the same letter (^{a,b,c}) in the same row are not significantly different ($p > 0.05$).

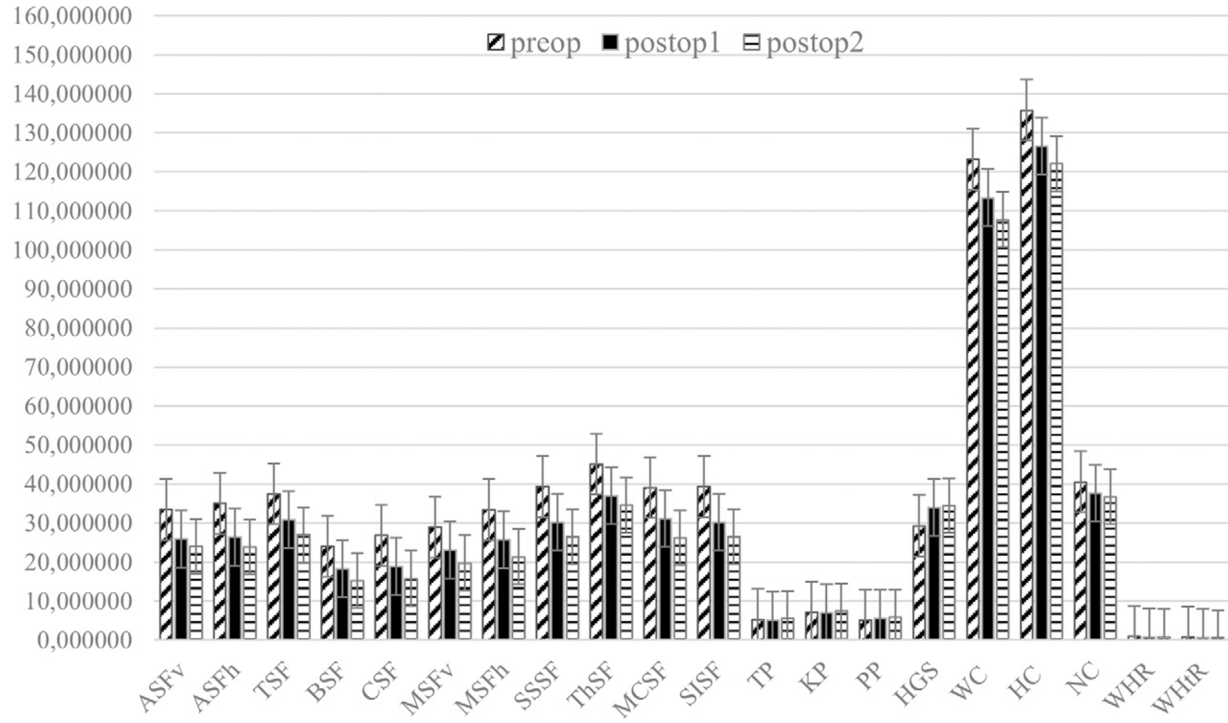

FIG. 1. Mean values of variables in preoperative and postoperative measurements. Vertical abdominal skinfold thickness (ASFv), horizontal abdominal skinfold thickness (ASFh), triceps skinfold thickness (TSF), biceps skinfold thickness (BSF), chest skinfold thickness (CSF), vertical midaxillary skinfold thickness (MSFv), horizontal midaxillary skinfold thickness (MSFh), subscapular skinfold thickness (SSSF), thigh skinfold thickness (ThSF), suprailiac skinfold thickness (SISF), medial calf skinfold thickness (MCSF), tip pinch (TP), key pinch (KP), Palmar pinch (PP), waist circumference (WC), hip circumference (HC), neck circumference (NC), hand grip strength (HGS), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR).

potential complications, some of which may be severe or even life-threatening. These include staple line leakage, postoperative hemorrhage, splenic injury, gastric stenosis, and the exacerbation or *de novo* development of gastroesophageal reflux disease (GERD).[24] It is important to note that LSG has been linked to adverse GERD outcomes and an inconsistent incidence of newly developed GERD. The recent studies have shown that a higher occurrence of GERD symptoms following LSG, with some cases requiring conversion to Roux-en-Y gastric bypass (RYGB) surgery.[26–29]

One-anastomosis gastric bypass (OAGB) is gaining increasing traction among bariatric surgeons. It ranks as the third most frequently performed bariatric procedure worldwide, following sleeve gastrectomy and RYGB.[30] Extensive multicenter studies, such as the recent research by Musella et al., have highlighted OAGB's efficacy in enhancing anthropometric measures while maintaining a favorable complication profile in the early and midterm postoperative phases.[31] Between July 2014 and February 2019, Pizza et al. conducted a retrospective evaluation of patients who had undergone OAGB and had a follow-up period of at least 12 months. A total of 241 patients were included in the study, and the authors reported significant improvements in anthropometric parameters, including BMI, %excess weight loss, and %total weight loss.[32]

Although OAGB has garnered substantial support, it remains a subject of debate due to persistent concerns regarding bile reflux and malabsorption-induced nutritional deficiencies.[31] Some studies have documented cases of OAGB being revised to RYGB due to bile reflux. On the contrary, multiple long-term follow-up studies have downplayed this issue.[33–36] Similar to other malabsorptive procedures, OAGB appears to be associated with a higher incidence of cholelithiasis compared to purely restrictive surgeries. In a prospective randomized controlled trial by Pizza et al., regular postoperative use of ursodeoxycholic acid for the first 6 months was found to significantly lower the occurrence of cholelithiasis after OAGB, with no reported cases of intolerance.[37]

Although it has been documented in the literature that LSG has been converted to RYGB due to the manifestation of GERD,[26–29] and that OAGB has similarly been revised to RYGB owing to bile reflux complications,[33–36] the anthropometric efficacy of both LSG and OAGB remains extensively

Table 2. Descriptive Statistics and *p* Value of Conicity Index and A Body Shape Index (ABSI) for Preoperative and Postoperative 1 Values (*n* = 24)

Measurements / *Indices*	*Preoperative median (Min–Max)*	*Postoperative median (Min–Max)*	p *Value*[a]
A body shape index	0.07 (0.06–0.08)	0.07 (0.06–0.08)	0.123
Conicity index	1.36 (1.16–1.45)	1.31 (1.11–1.45)	0.001

[a]Wilcoxon signed-rank test.

validated. Within the scope of the present study, the impact of LSG on anthropometric parameters was particularly pronounced and noteworthy. In the first 8 weeks postsurgery, significant reductions in body weight and skinfold thickness, indicative of fat mass loss, were observed alongside notable improvements in grip strength. To our knowledge, this is the first study from Türkiye to track anthropometric measurements after surgery and the first in the literature to comprehensively investigate reductions in skinfold thickness and regional fat tissue.

While body weight and BMI are common obesity indicators, they fail to distinguish between fat and muscle mass.[38] Alternative measures such as skinfold thickness, WC, HC, WHR, and WHtR provide more precise insights into fat distribution. Skinfold measurements are widely used due to their affordability and simplicity, while combining them with WC and HC improves predictive accuracy. Garcia et al. emphasized that combining skinfolds with circumferences yields more accurate body fat estimates.[39]

Sans et al. reported a 25% reduction in WC and HC and a 50% reduction in triceps skinfold thickness after 1 year in 103 morbidly obese women undergoing Roux-en-Y gastric bypass (RYGB).[40] Similarly, Strauss et al. observed a 30% reduction in the sum of skinfold thicknesses at four sites in 17 patients undergoing gastric banding over a 2.5-year follow-up.[41]

Our study provides the most comprehensive analysis of skinfold thickness reductions in LSG patients, assessing 9 sites and 11 measurements. Significant reductions in all skinfold thicknesses in the short-term postoperative period confirm the efficacy of LSG in reducing adiposity.

In addition, we evaluated static muscle strength changes, focusing on grip strength after bariatric surgery. Hand and pinch grip strength, noninvasive and cost-effective indicators of upper extremity muscle function, are increasingly recognized as predictors of mortality and morbidity in clinical settings.[21]

Previous studies have reported inconsistent results regarding changes in muscle strength after bariatric surgery. Alba et al. noted a decline in dynamic muscle strength 6–12 months post-RYGB, while Cole et al. and Colar et al. found no significant changes in HGS at 6 and 12 months postoperatively.[42–44] Similarly, Ibacache et al. observed reduced HGS at 1 and 3 months post-LSG, but other studies reported no significant changes in muscle strength.[21,45–48]

In contrast, our study demonstrated a significant increase in HGS during the first and second postoperative months (Table 1). In addition, we are the first to evaluate pinch strength in LSG patients, revealing significant improvements in KP and PP strengths between pre- and postoperative measurements (Table 1). These results highlight the positive impact of LSG on muscle strength in the early postoperative period, differing from prior studies. Gedmantaite et al. (2020) reported that grip strength was positively correlated with protein intake and diet quality. In our study, since a strict diet was started after the 15th day and protein intake was planned as 0.8–1.2 g/kg/body weight per day, the decrease in postoperative first month and the increase in postoperative second month changed depending on the protein intake process.[49]

Anthropometric measurements such as WC, HC, NC, WHR, and WHtR are widely used for evaluating obesity in bariatric surgery. Our results align with those reported by Ahuja, Shirazi, Carvajal, Shah, Hosseini-Esfahani, and Sans. For example, Talalaj et al. documented reductions of 22.1% in WC, 18.4% in HC, and 4.2% in WHR 12 months post-LSG. Shirazi et al. observed reductions of 17.1% in WC, 17.3% in HC, and 17.5% in WHtR, while Carvajal et al. reported decreases of 20% in WC, 14% in HC, and 10% in NC at 6 months.[39,40]

In our study, reductions of 12.5% in WC, 10.1% in HC, 10% in NC, 2.6% in WHR, and 12.5% in WHtR were observed within 2 months, demonstrating rapid postoperative changes and the efficacy of LSG in reducing obesity-related parameters.

CI, a reliable indicator of fat distribution, is cost-effective and effective in detecting abdominal obesity.[50] Shirazi et al. reported a 30% reduction in CI 12 months post-LSG.[38] In our study, a 4% reduction was observed within 2 months, underscoring its utility in early postoperative assessments.

ABSI, which adjusts WC for BMI and height, offers a refined measure of central adiposity and is an independent predictor of mortality. Gomez-Peralta et al. found significant pre- and postoperative differences in ABSI in gastric bypass and sleeve gastrectomy patients, highlighting its potential in bariatric outcomes.[51]

Conclusions

In conclusion, obesity is a chronic, multifactorial condition associated with numerous comorbidities and a high risk of recurrence despite treatment. LSG is an effective surgical option, but long-term success requires ongoing postoperative management, including lifestyle modifications in diet and physical activity.

Anthropometric assessments, such as skinfold thickness, circumferential measurements, WHtR, and CI, are essential tools for monitoring progress after LSG, providing a comprehensive evaluation of nutritional and metabolic status and helping reduce the risk of weight regain.

Our study is the first to comprehensively analyze short-term postoperative changes in skinfold thickness and integrate pinch strength testing with HGS assessments, offering a detailed evaluation of muscle function and body composition in postsurgical recovery.

Authors' Contributions

T.U.: Conceptualization (lead); methodology (lead); project administration (lead); supervision (lead); writing—original draft (lead). O.G.: Data curation (lead); formal analysis (lead); validation (lead). R.O.: Resources (equal); visualization (lead); writing—original draft (equal). E.U.: Writing—original draft (equal); writing—review and editing (equal). M.F.A.: Writing—original draft (equal); writing—review and editing (equal). H.E.Y.: Conceptualization (equal); project administration (equal); supervision (equal); validation (equal). Z.A.E.: Conceptualization (equal); resources (equal); validation (equal). H.O.: Conceptualization (equal); methodology (equal); resources (lead). B.B.: Resources (equal). B.K.A.: Writing—review and editing (equal). A.U.: Writing—review and editing (equal). K.D.: Writing—review and editing (equal). B.Y.: Writing—review and editing (equal).

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References

1. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in underweight and obesity from 1990 to 2022: A pooled analysis of 3663 population-representative studies with 222 million children, adolescents, and adults. Lancet 2024; 403(10431):1027–1050; doi: 10.1016/S0140-6736(23)02750-2
2. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet 2004;363(9403):157–163; doi: 10.1016/S0140-6736(03)15268-3
3. Cawley J, Biener A, Meyerhoefer C, et al. Direct medical costs of obesity in the United States and the most populous states. J Manag Care Spec Pharm 2021;27(3):354–366.
4. Ural D, Kılıçkap M, Göksülük H, et al. Türkiye'de obezite sıklığı ve bel çevresi verileri: Kardiyovasküler risk faktörlerine yönelik epidemiyolojik çalışmaların sistematik derleme, meta-analiz ve meta-regresyonu. Turk Kardiyol Dern Ars 2018;46(7):577–590.
5. Stegen S, Derave W, Calders P, et al. Physical fitness in morbidly obese patients: Effect of gastric bypass surgery and exercise training. Obes Surg 2011;21(1):61–70; doi: 10.1007/s11695-009-0045-y
6. Billington CJ, Epstein LH, Goodwin NJ, et al. Overweight, obesity, and health risk. Arch Intern Med 2000;160(7): 898–904; doi: 10.1001/archinte.160.7.898
7. Schelbert KB. Comorbidities of obesity. Prim Care 2009; 36(2):271–285; doi: 10.1016/j.pop.2009.01.009
8. Bobbioni-Harsch E, Bongard O, Habicht F, et al. Relationship between sympathetic reactivity and body weight loss in morbidly obese subjects. Int J Obes Relat Metab Disord 2004;28(7):906–911; doi: 10.1038/sj.ijo.0802620
9. Davy KP, Orr JS. Sympathetic nervous system behavior in human obesity. Neurosci Biobehav Rev 2009;33(2):116–124; doi: 10.1016/j.neubiorev.2008.05.024
10. Shah M, Simha V, Garg A. Long-term impact of bariatric surgery on body weight, comorbidities, and nutritional status. J Clin Endocrinol Metab 2006;91(11):4223–4231; doi: 10.1210/jc.2006-0557
11. Vanhecke TE, Franklin BA, Miller WM, et al. Cardiorespiratory fitness and sedentary lifestyle in the morbidly obese. Clin Cardiol 2009;32(3):121–124; doi: 10.1002/clc.20458
12. Fontaine KR, Redden DT, Wang C, et al. Years of life lost due to obesity. JAMA 2003;289(2):187–193; doi: 10.1001/jama.289.2.187
13. Cowan GS, Jr, Hiler ML, Buffington C. Criteria for selection of patients for bariatric surgery. Eur J Gastroenterol Hepatol 1999;11(2):69–75; doi: 10.1097/00042737-199902000-00003
14. Moly KT. Excessive weight loss and quality of life after laparoscopic sleeve gastrectomy—A correlational study. Indian J Public Health Res Dev 2019;10(6):314–319.
15. Kalfarentzos F, Dimakopoulos A, Kehagias I, et al. Vertical banded gastroplasty versus standard or distal Roux-en-Y gastric bypass based on specific selection criteria in the morbidly obese: Preliminary results. Obes Surg 1999;9(5): 433–442; doi: 10.1381/096089299765552701
16. Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: A systematic review and meta-analysis. JAMA 2004; 292(14):1724–1737; doi: 10.1001/jama.292.14.1724
17. Hutter MM, Schirmer BD, Jones DB, et al. First report from the American College of Surgeons Bariatric Surgery Center Network: Laparoscopic sleeve gastrectomy has morbidity and effectiveness positioned between the band and the bypass. Ann Surg 2011;254(3):410–420; doi: 10.1097/SLA.0b013e31822c9dac
18. Chung AY, Thompson R, Overby DW, et al. Sleeve gastrectomy: Surgical tips. J Laparoendosc Adv Surg Tech A 2018;28(8):930–937; doi: 10.1089/lap.2018.0392
19. Womersley J, Durnin J. A comparison of the skinfold method with extent of 'overweight' and various weight-height relationships in the assessment of obesity. Br J Nutr 1977;38(2):271–284; doi: 10.1079/bjn19770088
20. Demura S-I, Sato S. Suprailiac or abdominal skinfold thickness measured with a skinfold caliper as a predictor of body density in Japanese adults. Tohoku J Exp Med 2007;213(1): 51–61; doi: 10.1620/tjem.213.51
21. Otto M, Kautt S, Kremer M, et al. Handgrip strength as a predictor for post bariatric body composition. Obes Surg 2014;24(12):2082–2088; doi: 10.1007/s11695-014-1299-6
22. Mathiowetz V, Kashman N, Volland G, et al. Grip and pinch strength: Normative data for adults. Arch Phys Med Rehabil 1985;66(2):69–74.
23. Ryu K, Suliman ME, Qureshi AR, et al. Central obesity as assessed by conicity index and a-body shape index associates with cardiovascular risk factors and mortality in kidney failure patients. Front Nutr 2023;10:1035343; doi: 10.3389/fnut.2023.1035343
24. Gagner M, Hutchinson C, Rosenthal R. Fifth International Consensus Conference: Current status of sleeve gastrectomy. Surg Obes Relat Dis 2016;12(4):750–756; doi: 10.1016/j.soard.2016.01.022
25. Pizza F, D'Antonio D, Lucido FS, et al. Does antrum size matter in sleeve gastrectomy? A prospective randomized study. Surg Endosc 2021;35(7):3524–3532; doi: 10.1007/s00464-020-07811-1
26. Borbély Y, Schaffner E, Zimmermann L, et al. De novo gastroesophageal reflux disease after sleeve gastrectomy: Role of preoperative silent reflux. Surg Endosc 2019;33(3): 789–793; doi: 10.1007/s00464-018-6344-4
27. Felsenreich DM, Kefurt R, Schermann M, et al. Reflux, sleeve dilation, and Barrett's Esophagus after laparoscopic sleeve gastrectomy: Long-term follow-up. Obes Surg 2017; 27(12):3092–3101; doi: 10.1007/s11695-017-2748-9
28. Boru CE, Greco F, Giustacchini P, et al. Short-term outcomes of sleeve gastrectomy conversion to R-Y gastric bypass: Multi-center retrospective study. Langenbecks Arch Surg 2018;403(4):473–479; doi: 10.1007/s00423-018-1675-0
29. Salminen P, Helmiö M, Ovaska J, et al. Effect of laparoscopic sleeve gastrectomy vs laparoscopic roux-en-y gastric bypass on weight loss at 5 years among patients with morbid obesity: The SLEEVEPASS randomized clinical trial. JAMA 2018;319(3):241–254; doi: 10.1001/jama.2017.20313

30. Fisher BL, Buchwald H, Clark W, et al. Mini-gastric bypass controversy. Obes Surg 2001;11(6):773–777; doi: 10.1381/09608920160558777
31. Musella M, Susa A, Manno E, et al. Complications following the Mini/One Anastomosis Gastric Bypass (MGB/OAGB): A multi-institutional survey on 2678 patients with a mid-term (5 years) follow-up. Obes Surg 2017;27(11):2956–2967; doi: 10.1007/s11695-017-2726-2
32. Pizza F, D'Antonio D, Lucido FS, et al. Postoperative clinical-endoscopic follow-up for GERD and gastritis after one anastomosis gastric bypass for morbid obesity: How, when, and why. Obes Surg 2020;30(11):4391–4400; doi: 10.1007/s11695-020-04805-9
33. Kulich KR, Madisch A, Pacini F, et al. Reliability and validity of the Gastrointestinal Symptom Rating Scale (GSRS) and Quality of Life in Reflux and Dyspepsia (QOLRAD) questionnaire in dyspepsia: A six-country study. Health Qual Life Outcomes 2008;6:12; doi: 10.1186/1477-7525-6-12
34. Saarinen T, Räsänen J, Salo J, et al. Bile reflux scintigraphy after mini-gastric bypass. Obes Surg 2017;27(8):2083–2089; doi: 10.1007/s11695-017-2608-7
35. Eldredge TA, Myers JC, Kiroff GK, et al. Detecting bile reflux-the enigma of bariatric surgery. Obes Surg 2018; 28(2):559–566; doi: 10.1007/s11695-017-3026-6
36. Robert M, Espalieu P, Pelascini E, et al. Efficacy and safety of one anastomosis gastric bypass versus roux-en-y gastric bypass for obesity (YOMEGA): A multicentre, randomised, open-label, non-inferiority trial. Lancet 2019;393(10178): 1299–1309; doi: 10.1016/S0140-6736(19)30475-1
37. Pizza F, D'Antonio D, Lucido FS, et al. The role of Ursodeoxycholic Acid (UDCA) in cholelithiasis management after One Anastomosis Gastric Bypass (OAGB) for morbid obesity: Results of a monocentric randomized controlled trial. Obes Surg 2020;30(11):4315–4324; doi: 10.1007/s11695-020-04801-z
38. Rojhani-Shirazi Z, Amini M, Meftahi N, et al. Comparison of anthropometric measures in people with and without short-and long-term complications after laparoscopic sleeve gastrectomy. Comp Clin Pathol 2017;26(6):1375–1379; doi: 10.1007/s00580-017-2543-y
39. Garcia AL, Wagner K, Hothorn T, et al. Improved prediction of body fat by measuring skinfold thickness, circumferences, and bone breadths. Obes Res 2005;13(3):626–634; doi: 10.1038/oby.2005.67
40. Sans A, Bailly L, Anty R, et al. Baseline anthropometric and metabolic parameters correlate with weight loss in women 1-year after laparoscopic Roux-En-Y gastric bypass. Obes Surg 2017;27(11):2940–2949; doi: 10.1007/s11695-017-2720-8
41. Strauss BJ, Marks SJ, Growcott JP, et al. Body composition changes following laparoscopic gastric banding for morbid obesity. Acta Diabetol 2003;40: (Suppl 1):S266–S269; doi: 10.1007/s00592-003-0083-1
42. Alba DL, Wu L, Cawthon PM, et al. Changes in lean mass, absolute and relative muscle strength, and physical performance after gastric bypass surgery. J Clin Endocrinol Metab 2019; 104(3):711–720; doi: 10.1210/jc.2018-00952
43. Cole AJ, Kuchnia AJ, Beckman LM, et al. Long-term body composition changes in women following Roux-en-Y gastric bypass surgery. JPEN J Parenter Enteral Nutr 2017; 41(4):583–591; doi: 10.1177/0148607115625621
44. Coral RV, Bigolin AV, Machry MC, et al. Improvement in muscle strength and metabolic parameters despite muscle mass loss in the initial six months after bariatric surgery. Obes Surg 2021;31(10):4485–4491; doi: 10.1007/s11695-021-05634-0
45. Gallart-Aragón T, Fernández-Lao C, Castro-Martín E, et al. Health-related fitness improvements in morbid obese patients after laparoscopic sleeve gastrectomy: A cohort study. Obes Surg 2017;27(5):1182–1188; doi: 10.1007/s11695-016-2427-2
46. Neunhaeuserer D, Gasperetti A, Savalla F, et al. Functional evaluation in obese patients before and after sleeve gastrectomy. Obes Surg 2017;27(12):3230–3239; doi: 10.1007/s11695-017-2763-x
47. Noack-Segovia JP, Sánchez-López AM, García-García I, et al. Physical exercise and grip strength in patients intervened through bariatric surgery. Aquichan 2019;19(3):1–10; doi: 10.5294/aqui.2019.19.3.6
48. Saavedra PI, Cano-Cappellacci MA, Fuentes CM, et al. Physical fitness and physical activity in women with obesity: Short term effects of sleeve gastrectomy. Nutr Hosp 2019;36(4):840–845; doi: 10.20960/nh.02515
49. Gedmantaite A, Celis-Morales CA, Ho F, et al. Associations between diet and handgrip strength: a cross-sectional study from UK Biobank. Mech Ageing Dev 2020;189:111269; doi: 10.1016/j.mad.2020.111269
50. Martins CA, do Prado CB, Santos Ferreira JR, et al. Conicity index as an indicator of abdominal obesity in individuals with chronic kidney disease on hemodialysis. PLoS One 2023;18(4):e0284059; doi: 10.1371/journal.pone.0284059
51. Gomez-Peralta F, Abreu C, Cruz-Bravo M, et al. Relationship between "a body shape index (ABSI)" and body composition in obese patients with type 2 diabetes. Diabetol Metab Syndr 2018;10(1):21–28; doi: 10.1186/s13098-018-0323-8

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