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

Metric Measurements on LSG Patients

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Abstract

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 post-operative 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 pre-operatively and at the 1st and 2nd months post-surgery.

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 post-operative period.

Conclusion: This study is notable for being the first to comprehensively evaluate short-term changes in skinfold thickness following bariatric surgery. Additionally, it is pioneering in its application of the pinch strength test alongside the hand grip strength test in this context.

1. Introduction

Obesity is a major global health issue, driven partly by reduced physical activity due to technological advancements like automation and computerization. It imposes significant financial burdens on healthcare systems.[1] According to WHO's 2016 data, 1.9 billion adults are overweight, and 650 million (13%) are obese, with obesity rates of 39% in men and 15% in women.[2,3] In Türkiye, Ministry of Health data show obesity rates of 20.9% in women, 13.7% in men, and 17% overall.[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, non-alcoholic 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 complications.[13] It provides substantial benefits with minimal complications for most morbidly obese patients.[14] Typically considered after the failure of non-surgical methods like diet, exercise, and medications, it also improves obesity-related comorbidities and modifies fasting and satiety patterns.[15]

Laparoscopic sleeve gastrectomy (LSG) is a widely accepted bariatric procedure involving the removal of about two-thirds of the stomach, leaving a tube-shaped stomach.[16] The incision starts 4-5 cm from the pylorus and extends to the angle of His. Patients typically lose up to 20% of their total body weight within the first year.[16]

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.[17,18]

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.[19]

Post-bariatric 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 post-surgery.

2. Materials and Methods

2.1. 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 post-operative 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. Anthropometric assessments were performed at baseline and during the first and second post-operative 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.

2.2. Anthropometric Measurements

The data collection process was conducted 1–3 days before surgery and during the 1st and 2nd post-operative months. Demographic information was collected via a structured questionnaire, and 11 anthropometric measurements were taken from 9 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 (TSF), 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.[20] Circumferential measurements were taken in centimeters with a non-stretchable 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).[21]

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.

2.3. 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 Shapiro–Wilk test were used to examine the normality of the quantitative continuously variable. Descriptive statistics were presented using mean±SD, median(minimum-maximum) where appropriate. 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 using Bonferroni multiple comparison test (if assumptions were satisfied) otherwise the Wilcoxon signed-rank test was used. A value of $p < 0.05$ was accepted as statistically significant.

3. Results

Measurements were conducted preoperatively and at one and two months postoperatively, assessing ASFv, ASFh, TSF, BSF, CSF, MSFv, MSFh, SSSF, TSF, SISF, MCSF, TP, KP, PP, HGS, WC, HC, and NC. Descriptive statistics and intergroup comparisons are presented (Table 1). These statistics and comparisons visualized (Figure 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, TSF, MCSF, SISF, WC, HC, NC, WHtR, WHR, HGS, PP, and KP ($p < 0.05$) (Figure 1). However, non-significant changes were found for ASFv and HGS during the 2nd postoperative period ($p = 0.112$, $p = 1.000$, respectively). KP showed significance only in the 1st postoperative period, while WHR and PP showed changes only in the 2nd postoperative period (Table 1). TP remained non-significant across all time points ($p = 0.237$).

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

Table 1 should be here.

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Table 2 should be here.

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4. Discussion

In the first 8 weeks post-surgery, 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.[22] 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.[23]

Sans et al. reported a 25% reduction in WC and HC and a 50% reduction in triceps skinfold thickness (TSF) after one year in 103 morbidly obese women undergoing Roux-en-Y Gastric Bypass (RYGP).[24] 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.[25]

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.

Additionally, we evaluated static muscle strength changes, focusing on grip strength after bariatric surgery. Hand and pinch grip strength, non-invasive and cost-effective indicators of upper extremity muscle function, are increasingly recognized as predictors of mortality and morbidity in clinical settings.[19]

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-RYGP, while Cole et al. and Colar et al. found no significant changes in HGS at 6 and 12 months postoperatively.[26-28] Similarly, Ibacache et al. observed reduced HGS at 1 and 3 months post-LSG, but other studies reported no significant changes in muscle strength.[19,29-32]

In contrast, our study demonstrated a significant increase in HGS during the first and second postoperative months (Table 1). Additionally, 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.

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.[23,24]

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.[33] Shirazi et al. reported a 30% reduction in CI 12 months post-LSG.[3] 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. Huang et al. found significant pre- and postoperative differences in ABSI in gastric bypass and sleeve gastrectomy patients, highlighting its potential in bariatric outcomes.[34]

5. 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 post-surgical recovery.

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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)

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Table 1: Descriptive statistics and p values of the measurements (n=24)

Variables	Preoperative Mean∓SD and Median (Min-Max)	1nd Postoperative Mean∓SD and Median (Min-Max	2nd Postoperative Mean∓SD and Median (Min-Max)	*P*	*P* [1]	*P*[2]	*P*[3]
Vertical Abdominal Skinfold Thickness (ASFv) (mm)	33.41∓6.17[a]	25.87∓4.07[b]	24.00∓4.75[b]	0.000[$]	0.000[*]	0.112[*]	0.000[*]
Horizontal Abdominal Skinfold Thickness (ASFh) (mm)	35.02∓5.14[a]	26.41∓5.03[b]	23.85∓5.01[c]	0.000[$]	0.000[*]	0.000[*]	0.000[*]
Triceps Skinfold Thickness (TSF)(mm)	37.45∓5.74[a]	30.79∓3.76[b]	26.91∓5.01[c]	0.000[$]	0.000[*]	0.000[*]	0.000[*]
Biceps Skinfold Thickness (BSF) (mm)	24.00∓8.51[a]	18.25∓6.32[b]	15.25∓5.68[c]	0.000[$]	0.000[*]	0.000[*]	0.000[*]
Chest Skinfold Thickne (CSF) (mm)	26.83∓7.48[a]	18.89∓6.40[b]	15.79∓5.80[c]	0.000[$]	0.000[*]	0.001[*]	0.000[*]
Vertical Midaxillary Skinfold Thickness (MSFv) (mm)	28.91∓6.50[a]	23.02∓5.35[b]	19.75∓5.92[c]	0.000[$]	0.000[*]	0.000[*]	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[$]	0.000[*]	0.000[*]	0.000[*]
Subscapular Skinfold Thickness (SSSF) (mm)	38.0(34.0-47.0)[a]	30.0(21.0-40.0)[b]	26.0(18.0-41.0)[c]	0.000[&]	0.000[#]	0.000[#]	0.000[#]
Thigh Skinfold Thickne (ThSF) (mm)	45.08∓5.14[a]	37.00∓6.08[b]	34.54∓5.15[c]	0.000[$]	0.000[*]	0.008[*]	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[&]	0.000[#]	0.000[#]	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[&]	0.000[#]	0.000[#]	0.000[#]
Tip Pinch (TP) (lbs)	5.33∓1.31[a]	5.15∓1.10[a]	5.56∓1.10[a]	0.237[$]	1.000[*]	0.140[*]	1.000[*]
Key Pinch (KP) (lbs)	7.00(3.63-11.29)	6.44(4.72-11.29)[a]	7.30(5.08-11.88)[ab]	0.048[&]	0.331[#]	0.012[#]	0.324[#]
Palmar Pinch (PP) (lbs)	5.05∓1.33[a]	5.56∓1.71[a]	5.85∓1.44[a]	0.042[$]	0.445[*]	0.454[*]	0.062[*]
Hand Grip Strength (HGS) (kg)	29.27∓6.87[a]	33.95∓6.70[b]	34.44∓7.09[b]	0.000[$]	0.002[*]	1.000[*]	0.001[*]
Waist Circumference (WC) (mm)	123.16∓11.72[a]	113.41∓10.81[b]	107.75∓11.31[c]	0.000[$]	0.000[*]	0.000[*]	0.000[*]
Hip Circumference (HC (mm)	135.79∓8.93[a]	126.50∓8.45[b]	122.04∓7.89[c]	0.000[$]	0.000[*]	0.000[*]	0.000[*]
Neck Circumference (N (mm)	40.0(36.0-50.0)[a]	37.0(34.0-45.0)[b]	36.0(33.0-43.0)[c]	0.000[&]	0.000[#]	0.002[#]	0.000[#]
Waist-to-Hip Ratio (WHR) (mm)	0.906∓0.056	0.896∓0.052	0.882∓0.060	0.005[$]	0.128[*]	0.111[*]	0.017[*]
Waist-to-Height Ratio (WHtR) (mm)	0.760∓0.060[a]	0.700∓0.056[b]	0.665∓0.062[c]	0.000[$]	0.000[*]	0.000[*]	0.000[*]

1

[1] $: Repeated Measures ANOVA, &: Friedman test, #: Wilcoxon Signed Rank test, *: Bonferoni post hoc test., p: p value

Table 2: Descriptive statistics and p value of Conicity Index and A Body Shape Index (ABSI) for preop and postop 1 values (n=24)[1]

Measurements / Indices	Preoperative Median (Min-Max)	Postoperative Median (Min-Max)	*p* value[#]
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

[1] [#]: Wilcoxon Signed Rank test, [P1]: Comparıson of Preoperative-1nd Postoperative, [P2]: Comparıson of 1nd Postoperative- 2nd Postoperative, [P3]: Comparıson of Preoperative - 2nd Postoperative

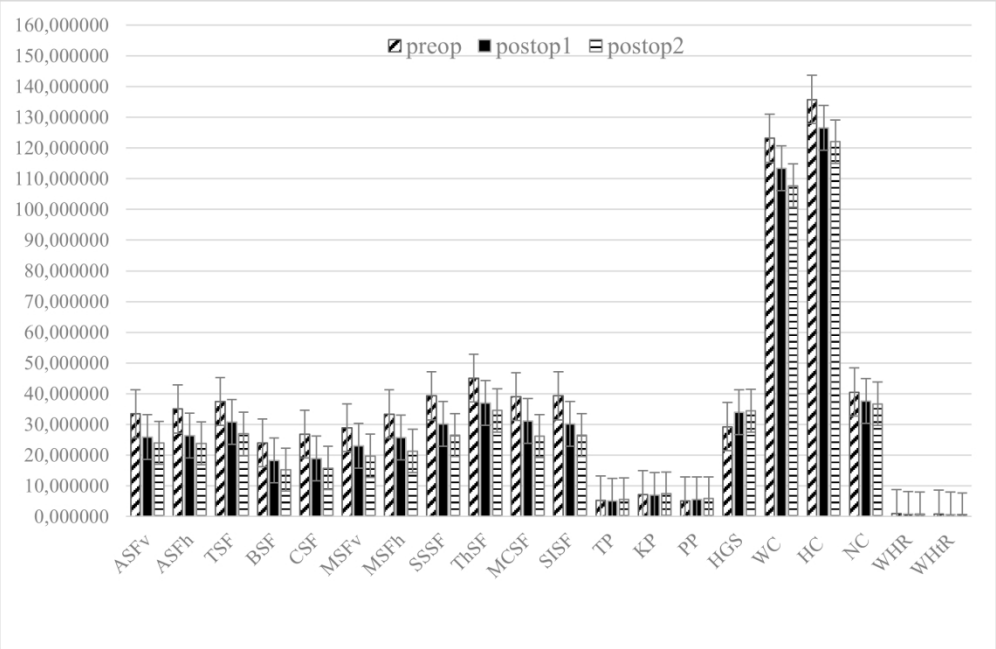

Fig.1 Mean Values of Variables in Preoperative and Postoperative Measurements
Vertical Abdominal Skinfold Thickness (ASFv), Horizontal Abdominal Skinfold Thickness (ASFh), Triceps Skinfold Thickness (TSF), Biceps Skinfold Thickness (BSF), Chest Skinfold Thickness (CSF), Vertical Midaxillary Skinfold 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)

442x287mm (118 x 118 DPI)