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RESEARCH ARTICLE

Effects of Supervised Exercise on Body Composition in Patients Succeeding Bariatric Surgery 1 year Longitudinal Study

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Abstract
This study aims to investigate whether a supervised, multicomponent exercise program can provide additional benefits on body composition after bariatric surgery. 18-65 year; body mass index (BMI) >35 kg/m^2; 54 patients (Exercise Group 29; Control Group 25) who had mini gastric bypass or Gastric Sleeve Surgery were included in the study. A verbal suggestion was made to the CG to increase physical activity, but this suggestion was not taken into consideration. The exercise group participated in a supervised multicomponent exercise program, 3 days a week, nonconsecutively, lasting 60 minutes each, for 11 months, starting 1 month after surgery. All variables were tested with two-way ANOVA test according to the effect of exercises on body weight (BW), fat mass (FM), fat-free mass (FFM) and BMI. After completion of descriptive statistics (mean ± SD), an independent t test was used to examine between-group differences in anthropometric components at baseline. Accordingly, there was no significant difference between the groups at baseline, including age, BW, BMI, FM and FFM ($p>.05$). Both groups experienced significant initial BW and FM loss, but these changes did not differ significantly between groups ($p>0.05$). On the other hand, FFM changes showed significant differences between groups ($p<.05$). Although there was no statistical difference in BW, FM and BMI values of the exercise group and the control group in this study, the positive change in the FFM of the exercise group was found to be significant compared to the control group. This clearly shows the importance of exercise in our study.

Keywords
Bariatric surgery; Exercise; Fat Free Mass; Fat Mass; Obesity

INTRODUCTION

Obesity is becoming an important global health problem, not only in healthcare but also increasingly in the economy (Cawley, 2015). For instance, the estimated cost of obesity in the America (USA) exceeds $ 260.6 billion annually (Cawley et al., 2021). There is increasing evidence that being overweight negatively affects functions like standing, walking, and stabilization of balance (Gonzalez, Gates, & Rosenblatt, 2020; King et al., 2016). It has been known that individuals who are obese or overweight face negative health problems such as diabetes, cancer, hypertension and cardiovascular disease (Guh et al., 2009; Wang, McPherson, Marsh, Gortmaker, & Brown, 2011) depression and other psychological disorders (McElroy et al., 2004). In addition, studies showing that obesity and overweight individuals, together with other diseases caused or accompanied by obesity, increase the rate of morbidity and mortality are increasing day by day (Abdelaal, le Roux, & Docherty, 2017; Flegal, Kit, Orpana, & Graubard, 2013; Lenz, Richter, & Mühlhauser, 2009). The data of the Ministry of Health Nutrition Research and TURDEP-II

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(Turkiye Diabetes, Hypertension, Obesity and Endocrinological Diseases Prevalence Study) studies report that 2/3 of adults in Turkey are overweight or obese. The prevalence of metabolic syndrome accompanied by central obesity is monitored in 36.6 % of the Turkish adult population. It is estimated that 3% of the adult population in our country (approximately 2.5 million adults) is morbidly obese (Sabuncu et al., 2018).

Methods such as adequate and balanced nutrition, physical activity, behavioral therapy and pharmacotherapy are the most commonly used methods in the treatment of obesity. If bariatric and metabolic surgery is to be implemented in the treatment of obesity, it is considered in patients with a body mass index (BMI) $\geq$ 40 kg/m^2 or in cases where BMI $\geq$ 35 kg/m^2 is accompanied by cardio metabolic diseases (De Lorenzo et al., 2016). Although it is stated that routine exercise is an important parameter in non-operative obese patients, exercising alone does not provide a significant reduction in body weight (BW) in such patients (Jakicic, 2009). There is limited information that exercise provides additional improvement in patients after bariatric surgery (BS). Still, when it comes to metabolic health, exercise is thought to provide greater improvement than BS (Coen & Goodpaster, 2016). The main reason why little is known about the positive results of exercise after BS is the lack of follow-up studies (Puzziferri et al., 2014).

In light of the above information, current study aims to search whether a supervised, multi-component exercise method can provide additional benefit such as BW, BMI, fat mass (FM) and fat free mas (FFM) after BS.

MATERIALS AND METHODS

Participants

Patients on the waiting list for BS were contacted, written informed consent was given, and a pre-surgical baseline assessment was performed 1 to 3 months prior to BS. Between the ages of 18-65; BMI >35 kg/m^2; Patients referred by a physician for mini gastric bypass (MGB) or Sleeve Gastrectomy (SG) surgery are included. The exclusion criteria were: health condition that prevented participation in exercise; amputation, amenorrhea >3 months, pregnancy or breastfeeding, and revisional bariatric surgery. This study is approved by the Şırnak University Ethics Committee (Approval Number: 2021/55). All participants gave their written informed consent, and our study was carried out following the Helsinki Declaration.

Study Design

Patients received usual medical care after BS, as defined in international guidelines, (Mechanick et al., 2013) including prescribing proton pump inhibitors for the first 2 months postoperatively, multivitamin supplements for the first 6 months, and Ursodeoxycholic Acid for the first 3 months. However, no specific calcium and vitamin D supplements were routinely recommended.

Verbal suggestion to increase physical activity was given to the control group, but it was not observed. In addition to usual medical care, the exercise group participated in a supervised multicomponent exercise program, 3 days a week non-consecutive, lasting 60 minutes each, for 11 months, starting 1 month after surgery. When designing the exercise program, The American College of Sports Medicine (ACSM) exercise recommendations for the obese were considered. (Pescatello, Riebe, & Thompson, 2013). The exercise program was organized as follows: warm-up (5 minutes); moderate-intensity aerobic exercise (25 minutes) resistance exercise (20 minutes) flexibility exercises and cool-down (10 minutes).

Aerobic exercise started at low intensity for the first 2 months (Heart rate reserve (HRR) 50%). Moderate intensity (HRR 50-65%) aerobic exercises were performed at 4, 5 and 6 months and high intensity (HRR 65-85%) aerobic exercises were performed from the end of 6 months. Resistance exercises were organized with 40-55% of 1 repeat of maximum (RM), 2-4 sets and 8-12 reps, with machines or free weights, to work large muscle groups. Flexibility exercises were performed as static, dynamic and/or proprioceptive neuromuscular facilitation (PNF).

Body compositions were measured at regular intervals before surgery, 1, 3, 6, and 12 months after surgery. Ethical approval was obtained from the University Ethics Committee for the current study, numbered 2021/55.

Nutrition Plan

The 1-year nutritionchart of theparticipatingpatients is as follows.

Stage 1: First day after surgery in the hospital	Non-Stop
Stage2 2. and 3. Day after surgery	Water, Tea, Herbal Tea, Protein Smoothie, Ayran, 100% Fruit Juice Diluted with Water
Stage 3 Liquid Nutrition 2 Week For 3–18 days after surgery 60–80 grams of protein everyday.	In Addition To The Liquids Consumed On The Second Day: Lactose Free Milk, Soup, Protein Smoothie, Sugar-Free Pudding, Yogurt, Kefir etc.
Stage4 Soft Foods 2 Week For19-30 day after surgery 60–80 grams of protein daily	Egg, Soft Cheese, Fish, mashed potatoes, ground forms of white meat, soft, ripefruit; Avoid tough peels, skin orseeds, Fresh vegetables cooked to softetc.
Stage5 Regular Solid Diet 1 Month For30-60 days after surgery 60–80 grams of protein daily	Scrambled eggs, omelets, alltypes of cheese, chicken, meatball, legumes etc.
Stage6 Optimal Nutrition Life-long Nutrition Plan	Protein: 60- 80 gram/day Carbohydrate: 40-45%of total energy Planned according to the patient

Anthropometric Measurements

The heights of the volunteers included in the study were calculated with a stadiometer (Holtain, UK), and their weight, skeletal muscle mass, lean mass and body fat percentage were calculated with a body impedance analyzer (A-401 Tanita, Japan).

Data Analysis

After the completion of descriptive statistics (mean ± sd) an independentt-test was used to examine between-group differences in anthropometric components at baseline. All variables, according to the effect of exercises on BW, BMI, FM and FFM was tested with a two-way ANOVA test. All statistical processes were conducted on SPSS program (Ver. 21) and the level of significance was set at 0.05.

RESULTS

Exercise and control groupsbaseline characteristics of pre-interventionare reported in Table 1.There were no significant differences between the groups at baseline, including age, BW, BMI, FM and FFM a result of the independent sample t-test (p>.05).

Table 1. Baseline descriptive characteristics of participants

Variables	Exercise group (n = 29)	Control group (n = 25)	p
Age (yr)	40±10	40.4±9	.280
Weight (kg)	123.5±23.6	123±22	.557
FM (%)	57,6±17.3	56,2±13.4	.267
FFM (%)	62.2±13.1	63.7±16.2	.993
BMI (kg/m^2)	44.6±8.3	44.7±7.4	.360

p<.05 FM: fat mass; FFM: fat free mass; BMI; body mass index

The effects of the intervention on anthropometric measures and body composition are shown in Table 2. Both groups lost a significant amount of initial BW, BMI and FM however, these changes did not significantly differ between groups (p>.05). On the other hand, FFM changes was significantly differ between groups (p<.05).

Table 2. Time-dependent change of body weight and body composition

	Exercise group (n=29)			Control group (n=25)			
	Pre	**6. month**	**12. month**	**Pre**	**6. month**	**12. month**	**P**
Weight	123.5±23.6	88.8±18	79.9±16	123±22	87.8±16.9	79.9±14.5	.827
FM	57,6±17.3	30.1±11	19.5±8.2	56±13.4	29.4±10.4	23.7±10.3	.069
FFM	62.2±13.1	59.4±12.5	60.5±12.2	63.7±16.2	55.2±12.4	52.5±8.5	.001*
BMI	44.6±8.3	31.8±6.5	29.9±6.2	44.7±7.4	31.9±5.7	29±4.9	.992

P<0.05 FM: fat mass; FFM: fat free mass; BMI; body mass index

DISCUSSION

BS is the most effective weight loss method among the interventions against obesity today. In a 2015 study, physicians concluded that they can benefit by directing patients to exercise after BS (Miller, Hale, & Dunlap, 2015). The American Society for Metabolic and Bariatric Surgery (ASMBS) specifically recommends a progressive walking program that includes pre-operative exercise and aerobic and strength exercises lasting 30 minutes or longer per day, starting on the first postoperative day (Petering & Webb, 2009). In some studies with patients who exercised 12-24 months after BS, it was reported that exercise-induced muscle strength and mass increased (Herring et al., 2017; Mundbjerg et al., 2018). In contrast, other studies investigating the effect of various forms of exercise after BS have not observed a significant increase in FFM or a significant decrease in FM (Andre et al., 2021; Bellicha et al., 2022; Daniels et al., 2018; Fagevik Olsén, Wiklund, Sandberg, Lundqvist, & Dean, 2022; Huck, 2015).

The main aim of the current study was to investigate whether exercise has a role in the change of body composition of patients undergoing BS. As a result of the study, there was a significant decrease in the FM and BW of the participants, measured before and 12 months after the BS operation, but no significant difference was found between the groups. On the other hand, the decrease in FFM of the exercise group was less than that of the control group.

Studies indicate that exercise affirmatively affects body composition after sudden weight loss caused by BS. Exercise usually changes body composition by increasing FFM and decreasing FM, not the percentage of total body mass lost after surgery. Relatively longer-term results are needed to evaluate whether the effect of exercise after BS is permanent (Metcalf, Rabkin, Rabkin, Metcalf, & Lehman-Becker, 2005). In the study by Daniels et al., 16 female patients after bariatric surgery were randomly divided into 2 groups and the intervention group underwent 12-week resistance exercise.At the end of the study, the exercise group showed an increase in the amount of strength compared to the control group, but no increase in FFM or muscle cross-sectional area was observed.Daniel et al.stated that the reason why they did not observe a change in FFM may be due to the severe decrease in calorie intake and the insufficient dietary protein necessary to stimulate protein synthesis.However, in the aforementioned study, 12 weeks of resistance exercises may not be sufficient to observe the muscle development of patients after bariatric surgery(Daniels et al., 2018).

In the current study, although there was no statistical difference in the BW, FM and BMI values of the exercise group and the control group, the positive change in FFM of the exercise group was found to be significant compared to the control group. This clearly shows the importance of exercise in our study.

Conclusion

As a result of the current study; It has been observed that the exercise program after obesity surgery is effective in increasing muscle mass but not losing fat mass. The reason why the exercise group did not show more decrease in fat mass then control group may be associated with the strong effect of the surgical intervention. When designing an exercise program, the fact that strength exercises are not progressive and the age group is wide range may limit the generalizability of the study's findings for all patients after bariatric surgery.

Conflict of interest

No conflict of interest is declared by the authors. In addition, no financial support was received.

Ethics Committee

This study is approved by the Şırnak University Ethics Committee (Approval Number: 2021/55).

Author Contributions

Planned by the author: Study Design, Data Collection, Statistical Analysis, Data Interpretation, Manuscript Preparation, Literature Search. Authors have read and agreed to the published version of the manuscript.

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