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# The Effect of Roux-en-y Gastric Bypass Surgery on Fitness Parameters in Women with Morbid Obesity

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## Abstract

**Background:** Obesity is widely considered as an important risk factor for impaired physical function and disability. Even mild to moderate weight loss has been shown to improve physical function. This study aimed to evaluate the effect of Roux-en-y gastric bypass (RYGB) surgery on some fitness parameters in women with morbid obesity.

**Methods:** Seventy two women with morbid obesity body were included in this study. They were followed for six months after RYGB surgery. Some fitness parameters including body composition (using bioelectrical impedance), muscular strength (leg press in lower limb and hand power grip in upper limb) and six minute walk test (6MWT) were evaluated before surgery and that at intervals of 1, 3 and 6 months after surgery. One way repeated measure ANOVA was applied to determine the data changes during the follow up period.

**Results:** BMI and body weight of all samples declined constantly during 6 months follow up after surgery. Also, by the end of the study, the body fat percent decreased from 48.2 (3) to 36.4 (4) ($P < 0.05$). The distance which patients paced in 6MWT increased 22% during 6 months follow up ($P < 0.0001$). Although handgrip and leg press of the participants decreased following the gastric bypass surgery, the power grip/weight ratio and leg press /weight ratio improved significantly through the study ($P < 0.0001$).

**Conclusions:** RYGB surgery may positively affect fitness parameters in morbid obese women. The endurance capacity, body composition and even muscle strength seem to be enhanced after gastric bypass surgery.

*Keywords:* RYGB, Morbid Obesity, Fitness, 6MWT, Power Grip, Leg Press

## 1. Background

Obesity as a major public health problem is increasing worldwide including Iran (1-3). It is sensible to note that one out of two adult people in Iran are over weighted and the prevalence of obesity is estimated to be around 24.5% and 10.9%in women and men respectively (2). Physical ability is adversely effected by obesity (4). Morbid obesity has been recognized as a strong risk factor for cardiovascular disease, cancer, stroke, endocrine disorder, sleep apnea and musculoskeletal disorders (5). Due to increased workload for a given amount of movement in those with a higher body mass index (BMI), marked plunged in motor ability and poor aerobic, anaerobic capacities are expected to seen among morbid obese popular (6). Various studies confirmed the negative impact of obesity on fitness parameters (7, 8). Furthermore bariatric surgery has been shown to provide a substantial weight loss, as a case in point, a meta-analysis resulted an average of 68.2% weight loss one year after gastric bypass procedures including Roux-en-y gastric bypass surgery(RYGB) (9). Very few studies have evaluated the effect of bariatric surgery on fitness parameters among morbid obese people (10). Although the majority of authors reported the positive effect of bariatric surgery on body composition and cardio respiratory fitness (11-13), the definite effect of bariatric surgery on other fitness parameters including muscle strength has remained unclear until now.

Thus, this study was conducted to determine the effect of RYGB surgery on functional improvement in morbid obese women.

## 2. Methods

### 2.1. Samples

During the period of approximately 2 years of this study, eighty morbid obese women (BMI $\geq$ 40) who were referred to the minimally invasive surgery research center, Iran University of Medical Science, for RYGB surgery, were

included in this cohort study. Eight participants left the study within six months follow up and finally 72 morbid obese women completed the study. All patients received information about the purpose of the study and written consent forms were obtained prior to study. All participants were reassured that the data would be kept confidential. Declaration of this study has been approved by ethics committee of Iran University of Medical Sciences (NO: 9311225003) and it was also registered in Iranian registry of clinical trial (IR.IUMS.FMD.REC 1396.25036).

Women older than 18 with BMI $\geq$ 40 kg/m$^2$ were participated in the study if they meet the inclusion criteria as follow: a sedentary lifestyle(less than 20 minutes of structured exercise twice weekly, no history of previous bariatric surgery and lack of any kind of orthopedic limitation. Patients were excluded from the study in case of their tendency for leaving the study or suffering from any post-operative side effects which may interfere with their fitness level.

### 2.2. Main Outcomes

The main dependent variables of this survey were power grip, six-minute walk test (6MWT), body composition and leg press which were performed before the surgery and also one, three and six months after the surgery.

#### 2.2.1. Power Grip

Power or hand grip is the result of maximum voluntary forceful flexion of all finger joints that the participant is able to exert under normal conditions.

The power grip was measured on dominant hand using the digital hand dynamometer Seahan Corp (model SH5003/Korea). The participants were in a sitting position with arms in 90° flexion and the elbow in full extension. They were asked to squeeze the dynamometer with as much force as possible. The test was repeated three times and the best result was recorded.

#### 2.2.2. 6MWT

It is a safe, easy and good tolerated functional test for the participants which reflect activities of daily living distance is considered as the primary measurement in 6MWT. The participants were asked to walk with their own maximum walking speed with standard verbal encouragement (14).

#### 2.2.3. Leg Press

The leg press test assesses the maximum muscular strength of the major muscles of the lower body.

The one repetition maximum (1-RM) was conducted to determine the lower leg muscle strength in the study (15). After completing the warm-up sets (with 50% 1-RM), the 1-RM testing for leg extension was begun, patients attempted to complete a 1-RM using a weight that was predicted to be the maximal weight that could be lifted. After 3 - 5 minutes recovery, the participants tried a higher weight load (16, 17). Epley formula was used to estimate the 1-RM (18).

Epley: $1RM = W \times (1 + 0.0333 \times R)$.

#### 2.2.4. Body Composition

Body composition analysis was obtained by bioelectrical impedance analyzer (model Tanita BC-418 MA/Japan). The participants were asked abstain severe exercise on the day before the exam and also avoid excessive consumption of food and fluid four hours merely before the test and to void 30 minutes prior to test is advisable. At the time of analysis the patients were asked to stand erect, barefoot with the minimal light clothing. The bioelectrical impedance analysis (BIA) was performed by applying four silver electrodes. After connecting the electrodes to the BIA instrument, the measurement was recorded in real-time by a computer.

### 2.3. Statistical Analysis

Considering power grip as the main variable and according to Otto et al. (19) study in which the mean (SD) of power grip before and 18 weeks after bariatric surgery was 31.24 (7) and 34.12 (9.3) respectively and type 1 error of 0.05 and type 2 error of 0.2, using G*power, a sample size of 72 for this study was obtained. Estimating the withdrawal rate of 10%, 80 patients were recruited. The information is given as mean and standard deviation. The one way repeated measure ANOVA was applied to determine the data changes during the follow up period and the paired T-Test was used for paired data. A P value less than 0.05 were considered significant. The SPSS (version 24, SPSS Inc, and Chicago, IL) was used to conduct the analysis.

## 3. Results

At the beginning 80 patients agreed to participate in the study. Eight participants were excluded from the study due to lack of completing follow-up sections (two patients for orthopedic injuries and six patients for lack of time and living in other cities). The characteristics of the participants are listed in Table 1.

During the 6 month follow-up period, one way repeated measure ANOVA showed significant difference in body weight at each of the post-operative points compared with the baseline(P value $<$ 0.0001) (Table 2).

The BMI decreased from 44.29 $\pm$ 4 kg/m$^2$ at baseline to 31.99 $\pm$ 4.7 kg/m$^2$ after 6 months (P value $<$ 0.0001). By the

**Table 1.** Demographic Data of the Participants at Baseline

| Variables | Before surgery, Mean (SD) | Minimum | Maximum |
|---|---|---|---|
| **Age** | 40.9 (10.2) | 19 | 50 |
| **Height, cm** | 160.02 (19.07) | 148 | 177 |
| **Weight, kg** | 116.78 (14.46) | 87.5 | 156.5 |
| **BMI, kg/m$^2$** | 44.29 (4.05) | 40.70 | 56.10 |
| **Fat percent, %** | 48.29 (3.56) | 40.20 | 55 |
| **Free fat mass, kg** | 59.94 (6.17) | 44.80 | 76 |

end of the study, the body fat percentage decreased from 48.2 $\pm$ 3 to 36.4 $\pm$ 4 (P value < 0.05). The amount of fat loss decrease was more significant after 1 month, although there was an insignificant increase in fat percent after 1 month (P value = 0.560).

The mean (standard deviation) distance walked in 6MWT after 6 months was considerably higher than baseline 422 (57.7) m at baseline vs. 514 (69.5) m after 6 months, (P < 0.0001). A greater amount of walking distance was apparent at each subsequent point after 1 month, although no significant difference was found between baseline and 1 month for 6MWT outcome(P = 0.589) (Table 2).

The mean (SD) preoperative value for power grip was 59.9 (13.83) kg. The minimum value was 29.30 kg and the maximum was 88.50kg. After one month there was a noticeable fall in handgrip to 51.2 (12.41) kg (P value < 0.0001).There was not a significant difference between 1 month and 3 months after follow up, however, after 6 months there was a significant rise in the power grip to 54.90 (12.25) kg after 6months vs. 51.29 (12.41) kg after 1 month) (Table 2).

The power grip/weight ratio was examined at the baseline and during follow up. Surprisingly this ratio improved significantly 3 and 6 months after the surgery (P value < 0.0001) (Figure 1).

The mean preoperative value for leg press was 98.7 kg. The minimum value was 50 kg and the maximum was 150 kg. One month after bariatric surgery, no significant difference was seen in leg press, although three and six months after the surgery marked decline was observed in leg press (P value < 0.0001) (Figure 2).

The leg press/weight ratio was examined and there was a significant improvement in results as early as 1 month after the surgery (P value < 0.0001) (Figure 3).

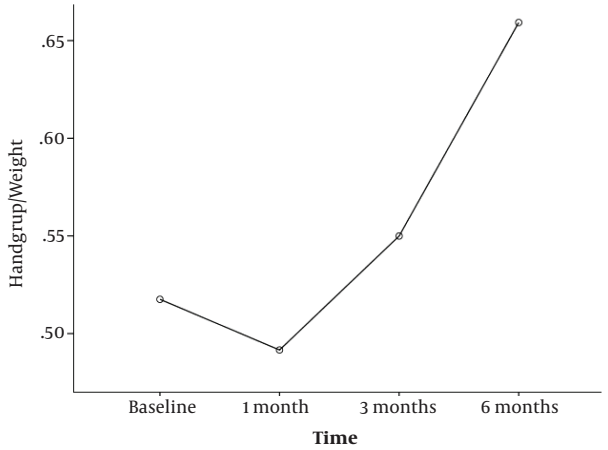


**Figure 1.** Handgrip/weight during 6 months follow up

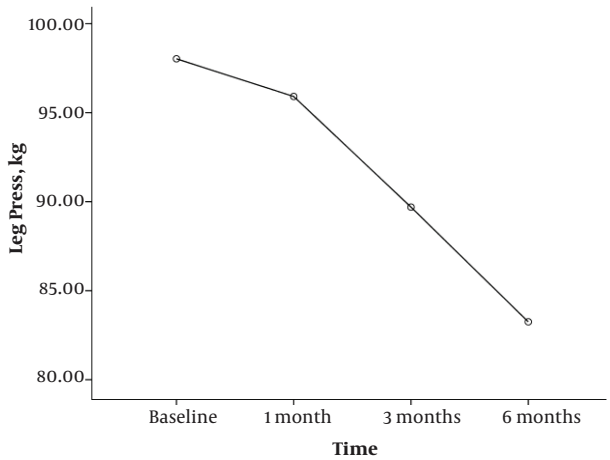


**Figure 2.** Leg press changes during 6 months follow up

## 4. Discussion

This study showed that some health-related fitness parameters including cardiac capacity, muscle strength and body composition improved after laparoscopic RYGB surgery in morbid obese women.

As expected, a significant weight reduction was observed within the first 6 months post-operatively. Additionally, BIA showed a substantial drop in body fat percent of patients. These findings are in agreement with the current literature (20-22).

The main goal of this study was to determine the effect of bariatric surgery on health-related fitness parameters among morbid obese women.

According to some previous studies (20-22), a reduction in absolute lower and upper extremities muscle strength (measured by leg press and hand grip respectively) is occurred after the bariatric surgery. How-

**Table 2.** Anthropometric Data and Physical Function Measurement at Baseline and 1, 3 and 6 Months After Bariatric Surgery[a]

| Variables | Baseline (N = 80), Mean (SD) | 1 month (N = 72) | | 3 months (N = 72) | | 6 months (N = 72) | | |
|---|---|---|---|---|---|---|---|---|
| | | Mean (SD) | P Value | Mean (SD) | P Value | Mean (SD) | P Value | Statistics |
| **BMI, kg/m$^2$** | 44.29 (4) | 39.8 (4.2) | < 0.0001[b] | 35.7 (4) | < 0.0001[b] | 31.99 (4) | < 0.0001[b] | F (3, 69) = 379.653 |
| **Weight, kg** | 116.7 (14.4) | 105.1 (14.5) | < 0.0001[b] | 94 (14.3) | < 0.0001[b] | 84.7 (13.8) | < 0.0001[b] | F (3, 69) = 457.304 |
| **TWL, %** | - | 26.2 (14.6) | < 0.0001[b] | 35.8 (14.4) | < 0.0001[b] | 43.8 (14.9) | < 0.0001[b] | F (2, 70) = 543.243 |
| **Fat percent, %** | 48.2 (3) | 51.6 (4) | 0.56 | 40.5 (4) | < 0.0001[b] | 36.4 (4) | < 0.05[b] | F (3, 68) = 180.453 |
| **6MWT, m** | 422 (57.7) | 444 (59.9) | 0.589 | 489.1 (70.9) | < 0.0001[b] | 514 (69.5) | < 0.0001[b] | F (3, 69) = 272.14 |
| **Power grip, kg** | 59.9 (13.83) | 51.2 (12.41) | < 0.0001[b] | 51.06 (12.04) | < 0.0001[b] | 54.90 (12.25) | < 0.0001[b] | F (3, 69) = 140.11 |
| **Leg press, kg** | 98.7 (33.18) | 95.9 (29.21) | 0.247 | 89.6 (27.52) | < 0.0001[b] | 83.2 (27.99) | < 0.0001[b] | F (3, 69) = 96.42 |
| **Power grip/weight, kg** | 0.51 (0.10) | 0.49 (0.11) | 0.002[b] | 0.55 (0.13) | < 0.0001 | 0.65 (0.15) | < 0.0001[b] | F (3, 69) = 73.249 |
| **Leg press/weight, kg** | 0.85 (0.30) | 0.96 (0.30) | < 0.0001[b] | 0.98 (0.35) | < 0.0001[b] | 0.99 (0.39) | < 0.0001[b] | F (3, 69) = 30.286 |

Abbreviations: BMI, Body Mass Index; %TWL, Percent Total Weight Loss.
[a] According to Mauchly's test, sphericity is violated in all of the variables so all P values are extracted from Greenhouse-Geisser test.
[b] P < 0.05, all P values are between baseline and post op periods.

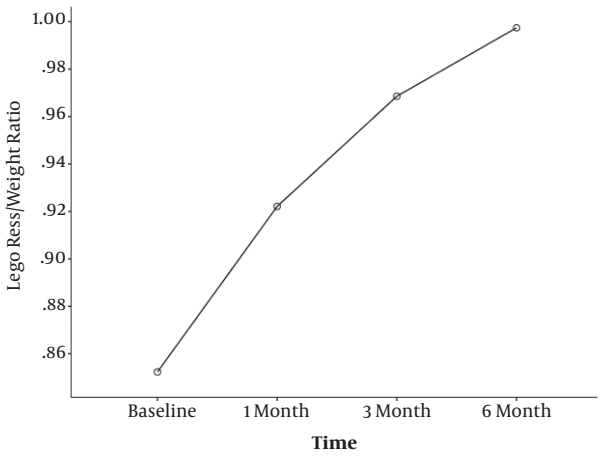


**Figure 3.** The Leg press/weight ratio during 6 months follow up

ever based on the hypothesis of this study, since muscle strength is directly related to the person's weight, evaluation of absolute muscle strength could not be a convinced method to assess the muscle strength of patients after the bariatric surgery. Thus although a significant reduction in absolute 1-RM leg press and power grip was observed during the 6 month follow up after the surgery in this study, when the leg press/weight ratio and the hand grip/weight ratio was assessed separately, an obvious enhancement was observed during the follow up period which clarifies an improvement in muscle strength after the bariatric surgery. It seems that no studies has been conducted until now to added the weight parameter to muscle strength evaluation after the bariatric surgery, thus all previous researchers reported a decrease in muscle strength after this surgery.

6MWT was used as a measure of functional capacity (cardio respiratory fitness) before and after the surgery in this study. There was a 22% increase in 6MWT distance after six months which may be correlated with significant decrease in patients' fat percent. This finding is in consistent with Vagas et al. and Hansen et al. studies demonstrating 20% increase in distance of a 6MWT, in 67 female patients three months after the Roux-en-Y gastric bypass (23). Maniscalco et al. showed a weak correlation between 6MWT and BMI changes in 15 female patients one year after the gastric banding (12). Hansen et al. showed an increased in 6MWT after the sleeve gastrectomy in 30 male and female patients 7 months after the surgery (24).

Several factors may be considered as the main limitations in this study. Firstly, among the entire one is the lack of control group which can limit the generalizability of these findings for all patients after the bariatric surgery. Second point is the fact that, calorie intake and protein consumption were not directly measured in this investigation, therefore their crucial impact could not be determined.

### 4.1. Conclusion

Considerable weight loss that accompanies gastric bypass surgery provides a significant increase in 6MWT distance as an indicator of cardio respiratory fitness; furthermore there is considerable increase in both upper and lower muscle strength following surgery which supports

the positive consequences of bariatric surgery on health-related physical fitness in morbid obese women.

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## Footnotes

**Conflict of Interest:** Authors declare that they have no conflict of interest regarding to this manuscript.

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