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ORIGINAL CONTRIBUTIONS

# Functioning of Obese Individuals in Pre- and Postoperative Periods of Bariatric Surgery

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**Abstract**
*Background* Obesity is a pathologic condition that causes functional incapacity, with reduction of quality of life and life expectancy and an increase in mortality. Bariatric surgery is indicated to alleviate associated comorbidities and increase physical capacity. The objective of this work was to evaluate the functional capacity of patients with morbid obesity before and after (3 months) bariatric surgery.
*Methods* This was a cross-sectional study involving 67 patients, where 61 were women and six men, with a mean age of 38±10 years and mean BMI of 50.45±8.5 kg/m$^2$. All patients were assessed before surgery and 3 months afterwards. The following assessments were performed: 6-min walk test (6MWT), functional independence measure (FIM), and test for risk of falling and transfer capacity, called the timed up-and-go test.
*Results* The study demonstrated a reduction in parameters evaluated in 6MWT with a statistically significant difference at two times (rest and final) when evaluated before and after bariatric surgery ($p<0.001$). In relation to the FIM and timed up-and-go test, the patients showed a statistically significant improvement ($p<0.001$) for both when comparing the tasks evaluated at the pre- and postoperative moments.
*Conclusions* Obesity has an impact on the functioning and quality of life of patients. We observed an improvement in all instruments used for assessment before and after bariatric surgery, where a linear component was demonstrated in relation to diminution of body mass index and functioning.

**Keywords** Obesity · Bariatric surgery · Six-minute walk test · Functional independence measure and mobility

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## Introduction

The long-term effects of obesity on the locomotor system are characterized by injuries that cause lower physical performance, consequently leading to a propensity for sedentarism and thereby decreasing the quality of life of these patients [1, 2]. Excess weight and a long duration of sedentarism exert a negative effect on muscle strength [3] and aerobic capacity [4], which are prerequisites for good mobility of the joints.

The physical performance of these obese patients depends on various factors, including degree of strength, range of movements, neurologic integrity, and degree of motivation [5]. It is known that functional capacity is characterized by a combination of functions that the individual performs in daily activities, which can thereby assess the degree of difficulty that the individual encounters to live [6].

In addition, obesity provides a disadvantage to the patient in performing physical activities, thereby resulting in a vicious cycle [7]. The first option in obesity treatment is a combination of increased physical activity and diet modification, but this is often unsuccessful. Therefore, bariatric surgery is indicated in these cases. Studies have reported that after surgery, the level of functional capacity in these patients improves, representing a decrease in risk of mortality and thereby having important long-term implications in quality of life [8–10].

Currently in the literature, there are no studies that demonstrate improvement in functioning and degree of motor and cognitive dependence of obese individuals after bariatric surgery. Thus, the objective of this study was to evaluate functioning using the 6-min walk test (6MWT), functional

independence measure (FIM) and timed up-and-go (TUG) test in obese patients evaluated before and after (3 months) bariatric surgery.

## Materials and Methods

### Sample

A cross-sectional study was conducted, which included all patients with morbid obesity, aged 20 to 50 years, evaluated before and 3 months after open Roux-en-Y gastric bypass at a reference center for obesity treatment. Excluded from the study were patients with such conditions as pulmonary diseases and severe cardiomyopathies, neurologic diseases, prior bariatric surgery or need for reoperation, and joint dysfunctions that would impede them from performing tests or patients who did not sign an informed consent form. This study was approved by the Committee on Ethics in Research of the Institution under protocol no. 561/11.

The sample was characterized by determining the presence of various comorbidities, including type 2 diabetes mellitus (DM2), systemic arterial hypertension (SAH), dyslipidemia, and cardiomyopathies. The patients were also questioned about smoking and alcohol consumption.

### Procedures

The preoperative evaluation included anamnesis, 6MWT, FIM, and final assessment of TUG. These same procedures were followed in postoperative evaluation, after a period of 3 months.

### Six-Minute Walk Test

6MWT was performed according to the guidelines of the American Thoracic Society [11]. The test consists of an evaluation of submaximal effort in which the patient has to walk the farthest distance possible in 6 min. The test was performed in a corridor of 30 m on the second floor of a hospital, where the patients wore sport clothes and comfortable gym shoes. During the test, every minute, the patients were encouraged to carry on with the test with phrases such as "You are doing well" and "Keep up the good work" besides informing them of the remaining time from the first to the fifth minute of evaluation. Before and after the test, the following parameters were determined: subjective sensation of exertion (Modified Borg Scale) where the value was expressed as a perception score of 0 to 10, respiratory rate (rpm), heart rate (bpm), and oxygen saturation (%) using an Onyx® II 9550 pulse oximeter, arterial pressure (mmHg) using a Palm HT 1500—Nissei sphygmomanometer and Littmann® Classic II stethoscope, and distance run in meters (m).

### Functional Independence Measure

The purpose of this scale is to determine the degree of functional dependence of patients [12]. This test gives an evaluation of two fields: motor and cognition. Motor aspect is composed of 13 items and subdivided into four categories: personal care, control of sphincters, mobility/transfer, and locomotion. Cognition aspect is composed of five items and divided into three categories: memory, communication, and social cognition. Each item is given a score varying from 1 (total assistance) to 7 (total independence) [12, 13].

### Timed Up-and-Go

This test is suitable for the activity domains of the International Classification of Functioning, specifically in evaluating and monitoring functional mobility and transfer capacity, interrelating with dynamic equilibrium, which can be used to demonstrate possible risks of falling and mobility [14]. The results of this test are expressed in seconds (s), time needed for the obese patient to get up from a chair, walk a distance of 3 m, turn around, walk back to the chair, and sit down again, demonstrating the time utilized for the task of getting up and sitting down. The patient performed the test one time to become familiar with it, and the time was recorded in the second try. The mean time of the classification score of this test indicates that scores over 20 s are indicative of compromise of mobility and functioning, more than 30 s indicates dependence in the majority of daily life activities (DLAs), and 10 s indicates total independence, pointing out that all these scores are established for the elderly population [14].

### Statistical Analysis

The categorical variables were described as absolute frequency and percent relative frequency. The quantitative variables were evaluated according to their distribution by Kolmogorov–Smirnov test, Student's *t*-test for paired samples was used for those with a normal distribution and two means, and ANOVA followed by Tukey's post-test was used for groups with more than two means. For variables with asymmetric distribution, Wilcoxon test was utilized for comparison of two distributions. Standardized effect size was evaluated to determine the magnitude of the effect. The quantitative variables were correlated by Pearson's correlation when the distribution was normal or by Spearman's correlation when the data were considered non-parametric. The level of significance was set at 5 % ($p \leq 0.05$).

## Results

This study evaluated 67 patients, including 61 (91 %) women and six (9 %) men, with a mean age of 38±10 years and

**Table 1** Characterization of sample evaluated in the preoperative period of bariatric surgery

| Characteristic | Patients, $n$=67 |
|---|---|
| Age (years) | 38±10 |
| BMI (kg/m$^2$) | 50.45±8.5[a] |
| Sex—female, *n* (%) | 61 (91)[b] |
| Alcohol use—*n* (%) | 9 (13.4) |
| Smoking—*n* (%) | 21 (31.3) |
| Dyslipidemias—*n* (%) | 27 (40.3) |
| Systemic arterial hypertension—*n* (%) | 49 (73.1) |
| Cardiomyopathy—*n* (%) | 17 (25.4) |
| Diabetes mellitus—*n* (%) | 30 (44.8) |

[a] Mean and standard deviation

[b] Values are expressed in absolute and relative frequencies

mean BMI of 50.45±8.5 kg/m$^2$. Among the comorbidities, the most frequent were SAH in 73.1 % of patients and DM2 in 44.8 % (Table 1). The capacity to tolerate exercise was determined by 6MWT, which showed in these patients at 3 months postoperative an improvement in the parameters respiratory rate, heart rate, and systolic and diastolic arterial pressure ($p$<0.001) compared to prior to surgery, both at rest and the end of the test (Table 2). With respect to perceived exertion with exercise (Borg scale), the patients in the post-operative period showed an improvement in this perception, that is, more tolerance to exercise (Table 2). Moreover, there was a significant increase ($p$<0.001) in distance run in meters by the patients in the post-surgical period when compared to the pre-surgical period (Table 3).

The degree of functional dependence determined by the FIM scale indicated that the post-bariatric surgery patients showed a higher score in relation to preoperative assessment ($p$<0.001) (Table 4). This increase in score for functional dependence was demonstrated in the two categories evaluated, motor and cognition, as well as in all the tasks tested within these categories ($p$<0.001), except for the task of communicating (Table 4).

Balance and transfer from sitting to standing were evaluated to determine the risks of falling, and 3 months after bariatric surgery, the patients showed a decrease in the time needed for the activity of sitting and standing ($p$<0.001) (Table 4).

## Discussion

Obese individuals have a low tolerance to exercise, showing as a consequence a low functional capacity. According to some authors, BMI is associated with functioning [1, 5, 15, 16], where the increase in distance run is related to improvement in clinical recovery from various diseases, including diabetes and metabolic syndrome. [17, 18].

Other authors report that this improvement is associated with an increase of 70 to 80 m in distance run [5, 15, 19], which corroborates with that found in our study (Table 3), where we observed with 6MWT an increase in distance run of 80 m in patients after 3 months in relation to preoperative assessment. This finding can be explained by the reduction in BMI observed in our patients in this period since the results showed a positive correlation between these two parameters ($r$=0.299; $p$<0.05), that is, the greater the

**Table 2** Parameters evaluated at two times (rest and final) of 6MWT in bariatric surgery patients in pre- and postoperative (3 months) periods

| Parameter | Preoperative | | Postoperative | | *P* (pre- and postoperative at rest) | *P* (pre- and postoperative at final) | TEP |
|---|---|---|---|---|---|---|---|
| | Rest | Final | Rest | Final | | | |
| Heart rate (bpm)[a] | 92±14 | 107±16 | 79±14 | 90±16 | < 0.001 | < 0.001 | 0.736 |
| | | | | | | | 0.969 |
| Respiratory rate (pm)[a] | 22±4 | 25±4 | 18±3 | 20±3 | < 0.001 | < 0.001 | 0.769 |
| | | | | | | | 1.059 |
| Systolic arterial pressure (mmHg)[a] | 131±10 | 145±16 | 121±10 | 128±18 | < 0.001 | < 0.001 | 0.759 |
| | | | | | | | 0.872 |
| Diastolic arterial pressure (mmHg)[a] | 87.2±8.3 | 90.8±14.7 | 81±10 | 85±11 | < 0.001 | < 0.001 | 0.477 |
| Oxygen saturation (%)[a] | 96±2 | 97±2 | 97±4 | 98±2 | 0.285 | 0.101 | 0.132 |
| | | | | | | | 0.206 |
| Borg dyspnea scale[b] | 0 (0–1) | 3 (1–6) | 0 (0 0) | 0 (0–1) | < 0.001 | < 0.001 | |
| Borg scale, upper and lower limbs[b] | 2 (0–4) | 5 (2–8) | 0 (0 0) | 0 (0–2) | < 0.001 | < 0.001 | |

*SES* standardized effect size

[a] Values expressed as mean ± standard deviation

[b] Values expressed as median (interquartile interval P25–P75)

**Table 3** Evaluation of the parameters weight, BMI, distance run, FIM and timed up-and-go scores (s) in pre- and postoperative periods and difference between the two periods

| Variables and tests | Preoperative | Postoperative | Difference | *P* |
|---|---|---|---|---|
| Weight | 132.61±23.66[a] | 104.29±23.13 | 28.31±16.44 | p<0.001 |
| BMI | 50.45±8.50 | 38.74±9.23 | 12.46 (12.46)[b] | p<0.001 |
| Distance run (m) | 405.34±92.26 | 500.10±111.63 | 80 (82.75) | p<0.001 |
| FIM | 114.97±6.77 | 123.46±4.37 | 8.49±6.27 | p<0.001 |
| Timed up-and-go (s) | 10.03±2.54 | 7.51±1.39 | 2.49±2.45 | p<0.001 |

[a] Values are expressed as mean ± standard deviation

[b] Values expressed as median (interquartile interval P 25–75); values with level of statistical significance for pre- and postoperative periods of 3 months ($p<0.001$)

difference in pre- and postoperative BMI, the greater the distance run by the patients. This finding is in line with some previous studies [2, 16, 20] that evaluated functional capacity after bariatric surgery, and it was found that patients with greater BMI tended to show shorter distance run.

Moreover, weight loss [15, 21] is associated with improvement in the capacity to tolerate exercise since many patients are incapable of doing intense exercises due to joint pain, rapid exhaustion, and mainly difficulty with walking [10, 22]. The concern with functional capacity involves the approach with respect to the perceived exertion scale. In our study, there was improvement in perceived exertion with exercise (Borg scale) with respect to dyspnea as well as to the muscles of the upper and lower limbs. This result was also obtained by some other authors [2, 5, 15] who carried out studies with obese patients, where the level of perceived exertion observed during walking was also reduced after bariatric surgery.

**Table 4** Functional independence measure tasks evaluated in pre- and postoperative (3 months) periods of bariatric surgery

| Tasks | FIM preoperative | FIM postoperative | *P* |
|---|---|---|---|
| Personal care | | | |
| Eating | 6.93±0.265 | 7±0.0 | 0.024 |
| Care for outer appearance | 6.79±0.445 | 6.99±0.122 | 0.001 |
| Toilet | 6.75±0.503 | 6.94±0.239 | 0.002 |
| Ability to dress upper part of body | 6.24±0.740 | 6.93±0.317 | <0.001 |
| Ability to dress lower part of body | 5.57±0.743 | 6.85±0.399 | <0.001 |
| Use of toilet | 6.57±0.679 | 6.97±0.171 | <0.001 |
| Control of sphincters | | | |
| Control of bladder | 6.21±0.789 | 6.87±0.423 | <0.001 |
| Control of defecation | 6.76±0.495 | 6.97±0.171 | 0.001 |
| Mobility (transfer) | | | |
| Transfer from bed, chair, wheelchair | 6.45±0.585 | 6.96±0.208 | <0.001 |
| Transfer to bathroom | 6.64±0.620 | 6.94±0.239 | <0.001 |
| Transfer to shower | 6.57±0.529 | 6.94±0.239 | <0.001 |
| Locomotion | | | |
| Walking on a level floor | 6.01±0.663 | 6.88±0.370 | <0.001 |
| Stairs | 5.57±0.701 | 6.70±0.628 | <0.001 |
| Communication | | | |
| Comprehension | 6.43±0.957 | 6.69±0.820 | 0.001 |
| Expression | 6.52±9.785 | 7.81±8.608 | 0.223 |
| Social behavior | | | |
| Social interaction | 6.43±0.679 | 6.73±0.617 | 0.005 |
| Problem solving | 6.48±0.612 | 6.84±0.412 | <0.001 |
| Memory | 6.51±0.683 | 6.76±0.605 | 0.016 |
| Score | 114.97±6.778 | 123.46±4.374 | <0.001 |
| Classification | 6.19±0.398 | 6.85±0.359 | <0.001 |

Values are expressed as mean ± standard deviation

Besides 6MWT, FIM shows good reliability of results with regard to the choice of a better type of intervention and monitoring of the clinical–functional state as a form of therapeutic planning. Our study demonstrated that the patients evaluated at 3 months after bariatric surgery had a better score for FIM (Table 4), as well as for the tasks tested, thus showing in this period total independence in the execution of tasks such as personal care, control of sphincters, mobility (transfer), locomotion, communication, and social behavior. It is known that functional independence and improvement in motor and cognitive tasks are associated with weight loss, where this fact is associated with patients who undergo the bariatric procedure [23]. The FIM scale [24] has been utilized as an assessment tool in the rehabilitation of obese patients after total hip arthroplasty, demonstrating that patients with BMI > 40 kg/m$^2$ show a score of complete dependence that is statistically greater in transfer, locomotion, and personal care tasks. Some authors report the importance of these questions regarding functional capacity because it provides the obese patient with autonomy after bariatric surgery [25, 26], such as autonomy in home activities, including preparing their own meals, washing and ironing clothes, going outside the home, grocery shopping, and even going up and down stairs. Meanwhile, incapacity makes it difficult or even impossible to perform these DLAs [21, 27, 28].

In our study, we observed that despite the patients showing scores within the normal range of FIM, which can be explained by the specificity of the scale utilized, an improvement of 7.38 % ($p<0.001$) was seen when comparing the scores of preoperative and 3-month postoperative examinations. Therefore, we can suggest that in this study, FIM was capable of assessing at pre- and postoperative times the incapacity of bariatric surgery patients with motor restrictions sensitive to physical–functional changes.

To detect the problems of balance and mobility that also affect DLAs in patients before surgery and 3 months afterwards, we conducted rapid monitoring by the use of TUG [23, 29]. Despite the excess weight of our patients, in the postoperative period, TUG was significantly lower by 25. 12 % in relation to preoperative values ($p<0.001$). This finding is in agreement with that reported by Ling et al. [22], who used TUG to evaluate gait and functioning in class III obese individuals, obtaining a mean of 10.32±1. 44 (s) when compared to eutrophic patients. Notably, this task is considered difficult since two tasks must be simultaneously performed, i.e., cognitive and mental, making it very difficult to pay specific attention to balance in walking and thus contributing to the risk of falling [30]. The most common causes of loss of balance and risk of falling, namely, physical inactivity, muscular weakness, and disturbances in bodily equilibrium, gait and mobility, are factors documented in the literature as being associated with overweight and/or obesity [7, 15, 21, 22].

These multiple factors associated with the functioning of patients in the pre- and postoperative periods of bariatric surgery are guided according to the World Health Organization and the International Classification of Functioning and Disability. Functional capacity evaluated with the cited instruments is important for recommending rehabilitation programs in the pre- and postoperative periods of bariatric surgery for the purpose of producing specific functional results for these patients.

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