Cardiorespiratory variables of the six-minute walking test of women submitted to bariatric surgery.

Research Article
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Postgraduate Program in Physical Therapy, Universidade Metodista de Piracicaba (UNIMEP), Piracicaba (SP), Brazil.


Keywords:
Morbid Obesity, Bariatric Surgery, Blood Pressure, Heart Rate, Walking.

Abstract
Introduction: It’s known that bariatric surgery provides an improvement in the functional capacity and cardiorespiratory performance. However, most of these studies are limited to the distance walked during the 6MWT as a function of the functional capacity. Objective: The goal of this study was to evaluate the functional capacity and cardiorespiratory responses of women with morbid obesity, applying the six-minute walk test before and 6 months after bariatric surgery. Method: Prospective and observational study in which 14 women with morbid obesity submitted to Roux-en-Y gastric bypass derivation were studied. The volunteers performed the six-minute walking test (6MWT) before and six months after surgery. The distance walked and the blood pressure were registered as well as the subjective sensation of dyspnea and exhaustion of the lower limbs. In addition, the heart rate, oxygen saturation and breathing rate were registered at the beginning, during the end of the 6MWT. Results: An increase in the distance walked was observed 6 months post-surgery (588.92 ± 34.81m) as compared to the preoperative distance (516.28 ± 50.91m). Regarding to the cardiorespiratory variables, which included the heart rate (HR), blood pressure (BP), peripheral oxygen saturation (SatO2), respiratory rate (RR) and sensation of dyspnea, there was a decrease in the systolic and diastolic blood pressures during the recovery period of the 6MWT. There was no statistical difference in the other variables analyzed. Conclusion: The bariatric surgery and the following weight loss provided improvements in the functional capacity and blood pressure values during recovery from the exercise.

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1. MSc, postgraduate Program Student in Rehabilitation Science, Universidade Nove de Julho (UNINOVE), São Paulo (SP), Brazil.
2. MSc in Physiotherapy, Universidade Metodista de Piracicaba (UNIMEP), Piracicaba (SP), Brazil.
3. MSc, postgraduate Program in Rehabilitation Sciences, Universidade Nove de Julho (UNINOVE), São Paulo (SP), Brazil.
4. Faculty of Physical Therapy, Universidade Metodista de Piracicaba (UNIMEP), Piracicaba (SP), Brazil.
5. MD, Bariatric Surgeon, Gastroenterology and Obesity Surgery Center of Piracicaba, Piracicaba (SP), Brazil.
6. PhD, Students of the National Program Postdoctoral (NPPD), Universidade Federal de São Carlos (UFSCar), São Carlos (SP), Brazil.
7. PhD, Postgraduate Program in Physical Therapy, Universidade Metodista de Piracicaba (UNIMEP), Piracicaba (SP), Brazil.

Correspondence:
Eli Maria Pazzianotto Forti - Rodovia do Açúcar, km 156, CEP 13400 911, Piracicaba – São Paulo, Brazil. Fax number: +55 19 3124 1500 Phone: +55 (19) 31241558 - E-mail: empforti@unimep.br
INTRODUCTION

Obesity is the world’s most common metabolic disease and its prevalence has increased greatly.\(^2\) In 2008, over 1.4 billion adults were overweight, and of these, over 200 million men and almost 300 million women were obese.\(^2\)

The bariatric surgery is considered to be one of the most accepted and effective methods in the treatment of morbid obesity, not only for weight loss, but also for reducing or eliminating weight-related diseases.\(^3,4\) These benefits can result in an improvement in the quality of life, functional capacity and increase in cardiorespiratory performance.\(^5\) Patients with severe obesity have decreased aerobic capacity, and it is possible to get an improvement from the weight loss after bariatric surgery.\(^6\)

The six-minute walking test (6MWT) is considered to be a simple, easily administered and low cost method, but previous studies were limited only evaluating the distance walked during the 6MWT as a function of the functional capacity. There are, however, other important measurements that can be evaluated during the 6MWT, such as the cardiorespiratory responses, including the heart rate (HR), blood pressure (BP), peripheral oxygen saturation (SatO2), respiratory rate (RR) and dyspnea.\(^7\)

Thus the purpose of this study was to evaluate the functional capacity and cardiorespiratory responses, that is the heart and respiratory rates, systolic (SBP) and diastolic blood pressures (DBP), peripheral oxygen saturation (SatO2), and the sensation of dyspnea in women with morbid obesity during the six-minute walking test.

Level of habitual physical activity

To assess the physical activity of individuals, they were questioned about sports, occupation and leisure habits, and the details quantified according to Baecke et al.\(^8\) The questionnaire included four questions about sports, eight about occupational activities and four on leisure habits. According to the scores obtained, the subjects were classified as sedentary, active or trained.

Six-minute walking test

The test was carried out in a 30 meter-long level corridor marked at every meter. The women received instructions to walk from the beginning to the end of the corridor as fast as they could for 6 minutes, being motivated every minute using standardized phrases.\(^9\)

The blood pressure was registered before, during and at the end of the test, using a BIC \(^\circledast\) sphygmomanometer for the obese, the heart rate using a RS800CX model Polar \(^\circledast\) cardiac frequency meter, respiratory rate frequency with a stopwatch, peripheral oxygen saturation using an Onyx 9500 model Nonin Medical Inc \(^\circledast\) pulse oximeter, and the feeling of dyspnea according to the Borg dyspnea scale.\(^10\) Figure 1 shows the times the cardiorespiratory variables were collected.

Each participant did the test twice. The second test was applied 30 minutes after the first one, as soon long as the values for BP, HR and RR had returned to the original ones. The cardiorespiratory variables obtained in the test with the longest walked distance were used for the analysis. The expected value for the distance walked in the 6MWT was calculated using the Enright and Sherril equation.\(^11\)
Statistical analysis
All the statistical procedures were found in the Bioestat 5.3 scheme, and the results presented as the mean and standard deviation. The normality of the data was verified using the Shapiro-Wilk test, and the student T test applied to related samples when normality was found for the variables of the anthropometric characteristics and for the distances obtained in the 6MWT. The Friedman test was applied in the absence of normality for the cardiorespiratory data from the 6MWT. A 5% level of significance was adopted for all the analysis.

RESULTS
Initially 35 volunteers were selected, but of these, only 30 performed the first 6MWT (from 15 to 30 days prior to bariatric surgery). The volunteers were contacted again 6 months after surgery in order to carry out the second 6MWT. Of the 30 that performed the first 6MWT, 10 did not want to do the second, 3 had new contact information and 3 did not undergo surgery. Thus 14 volunteers took part in the complete study, carrying out the 6MWT before and after bariatric surgery. Table 1 shows the data related to the anthropometric characteristics and physical activity levels of the volunteers at both evaluation times.

Table 1. Age and anthropometric data in the obese women before and after bariatric surgery.

<table>
<thead>
<tr>
<th></th>
<th>Before surgery</th>
<th>After surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>32.26 ± 5.79</td>
<td>33.14 ± 5.64*</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>161 ± 4.85</td>
<td>161 ± 4.85</td>
</tr>
<tr>
<td>Body mass (kg)</td>
<td>121.16 ± 12.80</td>
<td>87.06 ± 10.91*</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>46.71 ± 4.17</td>
<td>33.64 ± 4.68*</td>
</tr>
<tr>
<td>LLPA score</td>
<td>1.19 ± 1.13</td>
<td>1.40 ± 0.58</td>
</tr>
<tr>
<td>Total score</td>
<td>3.28 ± 1.31</td>
<td>3.80 ± 0.97</td>
</tr>
</tbody>
</table>

Values were expressed as the mean plus standard deviation. BMI: body mass index, LPA: leisure physical activity, LLPA: leisure physical activity and locomotion. (*) p<0.05: difference between the values obtained before and after surgery.

Table 2. Distances walked and predicted in meters during the 6MWT before and after bariatric surgery.

<table>
<thead>
<tr>
<th></th>
<th>Before surgery</th>
<th>After surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance walked</td>
<td>516.28 ± 50.91</td>
<td>542.94 ± 25.45</td>
</tr>
<tr>
<td>Distance predicted</td>
<td>588.92 ± 34.81*</td>
<td>612.08 ± 32.15</td>
</tr>
</tbody>
</table>

(*) p<0.05: difference between distance obtained before and after surgery.

DISCUSSION
Evaluating the cardiorespiratory variables for the 6MWT, it can be seen that the BP behaved in the expected manner during physical exercise, example, an increase in the SBP and maintenance of the DBP. Such findings are justified since there is a widespread vasodilatation during the exercise, which decreases the peripheral muscle resistance, explaining the maintenance of the DBP. However an increase in sympathetic nerve activity also occurs, which is triggered by the activation of the central command and muscle mechanoreceptors, contributing to the increases in HR and SBP.

However, it was observed that after weight loss, the values for SBP were smaller and recovery was better. Concerning the DBP, it was noted that this remained constant at the different evaluation times, but sixth months after surgery, it showed a significant decrease in the sixth minute of recovery. This confirms that the...
weight loss following bariatric surgery provides positive changes in the cardiorespiratory responses during the six-minute walking test.

A study carried out showed that reductions of 10 and 5 mmHg for SBP and DBP, respectively, could reduce the long-term risk of death from ischemic heart disease by 40%.(15) In the present study, an average reduction of 15 mmHg was observed in the systolic blood pressure before the test and 23, 16 and 4 mmHg in the second, fourth and sixth minutes of the 6MWT, respectively. There was also a mean reduction in DBP of 10 mmHg at rest and 16, 15 and 15 mmHg DBP in the second, fourth and sixth minutes of recovery from the test, respectively.

Considering that at all moments there was a decrease of at least 5 mmHg in the SBP and DBP, the hypothesis that bariatric surgery reduces the risk of cardiovascular events becomes stronger. In a study it was shown that of about 20,000 people submitted to bariatric surgery, 63% showed improvement in their hypertension levels, 73% in their diabetes condition and 65% in their lipid profile levels. (16)
The reduction in systemic BP after bariatric surgery could be due to the substantial decrease in the levels of circulating lipids and glucose, together with a concomitant reduction in the production of insulin associated with an increase in sensibility to this hormone and consequent improvement in glucose consumption. In addition, the decrease in sympathetic hyper-activation as a result of the decrease in leptin levels and the decrease in chronic intra-abdominal hypertension characteristic of morbid obesity, are also important mechanisms contributing to the decrease in systemic blood pressure after bariatric surgery.

After bariatric surgery there was a significant increase in the distance walked showing that the functional capacity improved after weight loss. When the distance walked was compared with the expected distance found in the literature reviewed in the present study, no statistical difference was found between the values, showing that the volunteers walked the expected distance for their weight, age and height, according to the equation proposed by Enright and Sherriff.

No studies comparing the distances walked with the expected distances of obese populations could be found in the literature, only between obese and eutrophic populations or comparing successive time intervals after certain interventions, either surgical or by physical exercise, thus limiting a wider exploration of the present results and discussion.

Some studies, aiming to evaluate the functional capacity, showed an increase of the distance walked in the 6MWT one year after bariatric surgery.

A study showed that the weight loss resulting from bariatric surgery failed to improve the functional capacity of women evaluated by the 6MWT, unlike the women undergoing an aerobic training program. This result can be explained by the fact that the obese women were evaluated during a period of 4 months after surgery, whereas in the present study they were evaluated 6 months after surgery. The literature shows that the majority of the weight loss occurs within the first 6 months, and hence the extra 2 months for the second evaluation may have lead to the increase in the distance walked in the present study.

In another study with 188 severely obese women, it was shown that musculoskeletal pain, especially in the lower limbs, was an important reason for an early interruption of the test. In the present study, the biggest complaint by the volunteers at the end of the test was also lower limb fatigue overlapping with dyspnea, although all of them performed the test up to the end. There was no statistical difference in the sensations of fatigue and dyspnea in the obese women studied after bariatric surgery.

Although an improvement in functional capacity was verified, with an increase in distance walked, this fact was not evident in the questionnaire on physical activity, which showed small changes in life habits, without changing the sedentary lifestyle evaluated previously. This could be explained by the fact that the questionnaire evaluates the last 12 months and maybe the last 6 months of physical activity of the volunteers were not enough to provide significant changes in the score of the questionnaire.

Common factors in severely obese individuals, such as low aerobic capacity and low tolerance for exercise, because of the metabolic demand increased by the extra-muscular work necessary to compensate the excess of body mass, stimulate the sedentary lifestyle of these patients. The subjects of this study showed a significant increase in the leisure time physical activity score after bariatric surgery, but still showed a sedentary lifestyle according to Baecke et al., in which only total scores higher than eight feature an active lifestyle.

Regarding the other cardiorespiratory variables, no differences were observed in the HR, RR and SatO2 during the 6MWT or during the recovery phase. As for SatO2, the literature shows that a decrease of 4% as compared to the baseline should be considered as oxygen desaturation. In the present study the reduction of SatO2 during 6MWT and recovery did not exceeded 3%.

The HR behaved as expected, with considerable increase at the beginning of the exercise due to vagal withdrawal, maintenance during the following few minutes, and finally returning to the baseline during recovery, but with a slight decrease in the HR after weight loss, with no statistical difference.

The walking test is used to evaluate the functional capacity of limited patients who are not capable of tolerating other functional capacity tests due to pain, quick tiredness and walking difficulty. The walking capacity is an important component of the quality of life, for it reflects the ability to carry out daily tasks. Thus the 6MWT is considered to be an effective method to evaluate the physical and functional capacity in the obese.

However, the following limiting factors can be considered in the present study. The first would be the fact that the 6MWT is limited by time since most patients do not reach their maximum exercise capacity during the 6MWT because they elect their own exercise intensity at a sub-maximum level. Another factor would be that during the period evaluated, despite the weight loss, 78% of the volunteers were still obese. Thus if an evaluation were carried out one year after surgery, by which time the volunteers should have a BMI closer to normality, it should be possible to verify bigger changes in their cardiorespiratory responses.

CONCLUSION

It can be concluded that a period of just 6 months after bariatric surgery was sufficient to promote an im-
provement in the functional capacity and blood pressure during recovery from the exercise. However, more extensive monitoring of this population is encouraged for a period of time longer than 6 months, with accompa-
niment of the functional capacity and appropriate orien-
tation of the physical activity, in order to make it pos-
sible to identify greater effects on the cardiorespiratory variables during exercise as a result of bariatric surgery.

REFERENCES