

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

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Resumo

Introdução: A cirurgia bariátrica promove melhora da capacidade funcional e aptidão cardiorrespiratória, porém grande parte dos estudos limita-se a utilizar somente a distância percorrida no teste de caminhada de seis minutos (TC6) como resultado da capacidade funcional. **Objetivo:** O objetivo deste estudo foi avaliar a capacidade funcional e as respostas cardiorrespiratórias de mulheres com obesidade mórbida a partir do TC6, antes e após seis meses da cirurgia bariátrica. **Método:** Estudo prospectivo, observacional e longitudinal, no qual foram estudadas 14 mulheres com obesidade mórbida, submetidas à derivação gástrica em Y de Roux. As voluntárias realizaram o TC6 antes e após seis meses do procedimento cirúrgico. Foram registradas a distância percorrida e a sensação subjetiva de dispnéia e cansaço de membros inferiores, além da frequência cardíaca, saturação de oxigênio e frequência respiratória coletadas no início, durante e ao término do TC6. **Resultados:** Foi observado aumento significativo na distância percorrida no período pós-operatório ($588,92 \pm 34,81\text{m}$) em comparação ao pré-operatório ($516,28 \pm 50,91\text{m}$). No que se refere às variáveis cardiorrespiratórias que incluem a frequência cardíaca, pressão arterial, saturação periférica do oxigênio, frequência respiratória e sensação de dispnéia houve redução da pressão arterial sistólica e diastólica no período de recuperação do TC6. Não houve diferença estatística nas outras variáveis analisadas. **Conclusão:** Pode-se concluir que a realização de cirurgia bariátrica e, conseqüente perda de peso promoveu melhora da capacidade funcional e melhora nos valores de pressão arterial durante a recuperação do exercício.

Palavras-Chave: Obesidade mórbida, Cirurgia bariátrica, Pressão arterial, Frequência cardíaca, Caminhada.

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 ($588.92 \pm 34.81\text{m}$) as compared to the preoperative distance ($516.28 \pm 50.91\text{m}$). Regarding to the cardiorespiratory variables, which included the heart rate (HR), blood pressure (BP), peripheral oxygen saturation (SatO_2), 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.

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

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INTRODUCTION

Obesity is the world's most common metabolic disease and its prevalence has increased greatly.⁽¹⁾ 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⁾

Considering that the work of morbidly obese patients is increased for certain activities, and that this changes the functional and cardiorespiratory capacity, this suggests that the weight loss resulting from bariatric surgery should provide changes in the functional capacity, increasing the distance walked and improving the cardiorespiratory responses during the six-minute walking test.

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, before and 6 months after bariatric surgery.

MATERIALS AND METHODS

This was a prospective observational study approved by the Ethics Committee of the Institution (Protocol 19/10). All the subjects were informed about the objectives of the study and signed an informed consent form. The patients were initially screened and subsequently evaluated in the laboratory for assessment and intervention in the Cardiorespiratory Physiotherapy of the institution.

The study included women aged between 20 and 40 years with a body mass index (BMI), submitted to bariatric surgery such as the laparotomy Roux-en-Y gastric bypass. Women with arterial hypertension, diabetes, cardiovascular or lung diseases, a history of smoking, stress-caused urinary incontinence (effort incontinen-

ce), peripheral vascular obstructive disease and musculoskeletal disorders that could cause difficulties during the test were excluded.

A sample calculation carried out using the BP values with 90% power, determined the need of nine volunteers in this study.

The patients were evaluated in the preoperative period (between 15 and 30 days before surgery) and again postoperative (six months after surgery). Initially, information on their medical history, anthropometric measurements and physical activity level was obtained, and subsequently the functional capacity was evaluated using the 6MWT.

Anthropometric evaluation

The volunteers were placed in the standing position with no shoes or heavy clothing. The body mass was obtained using a digital scale (Filizola® Brazil) duly calibrated with a maximum capacity of 300 kg and a resolution of 100 grams. The height was measured using a wall stadiometer. The BMI was calculated using the equation: weight (kg) / height² (m).

Level of habitual physical activity

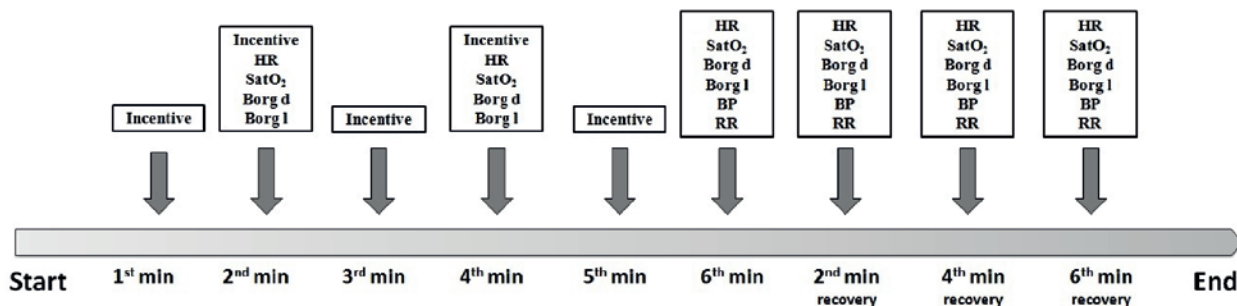
To assess the physical activity of individuals, they were questioned about sports, occupation and leisure habits, and the details quantified according to Baecke et al.⁽⁸⁾ The questionnaire included four questions about sports, eight about occupational activities and four on leisure habits. According 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® sphygmomanometer for the obese, the heart rate using a RS800CX model Polar® cardiac frequency meter, respiratory rate frequency with a stopwatch, peripheral oxygen saturation using an Onyx 9500 model Nonin Medical Inc® 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 the analysis. The expected value for the distance walked in the 6MWT was calculated using the Enright and Sherril equation.⁽¹¹⁾



HR: heart rate; SatO₂: peripheral oxygen saturation; Borg d: Borg dyspnoea; Borg l: Borg legs; BP: blood pressure; RR respiratory rate.

Figure 1. Diagram of collection of cardiorespiratory variables during the 6MWT.

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 did 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 did 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.

Figures 2 and 3 show the data for the cardiorespiratory variables obtained during the 6MWT and during the recovery process after the 6MWT. A statistical difference can be seen for the SBP (second, fourth and sixth minute of recovery) and DBP (sixth minute of recovery) variables. There was no statistical difference for the remaining variables.

Table 2 shows the data for the expected and walked distances at both evaluation times. A significant improvement was noted (95.8 meters) in the distance walked 6 months after surgery. There was no difference between the expected and walked distances 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.⁽¹²⁾ 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.⁽¹³⁾ 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.^(13,14)

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

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

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

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.

Before surgery		After surgery	
Distance walked	Distance predicted	Distance walked	Distance predicted
516.28 ± 50.91	542.84 ± 25.45	588.92 ± 34.81*	612.08 ± 32.15

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

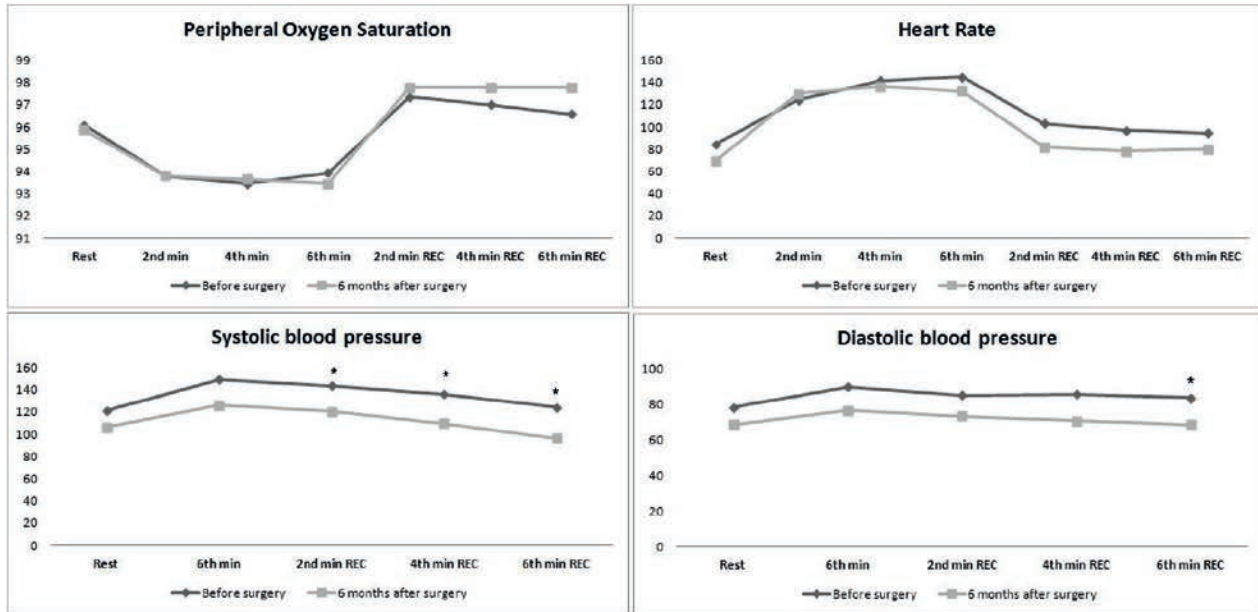


Figure 2. Performance of cardiorespiratory variables during the 6MWT

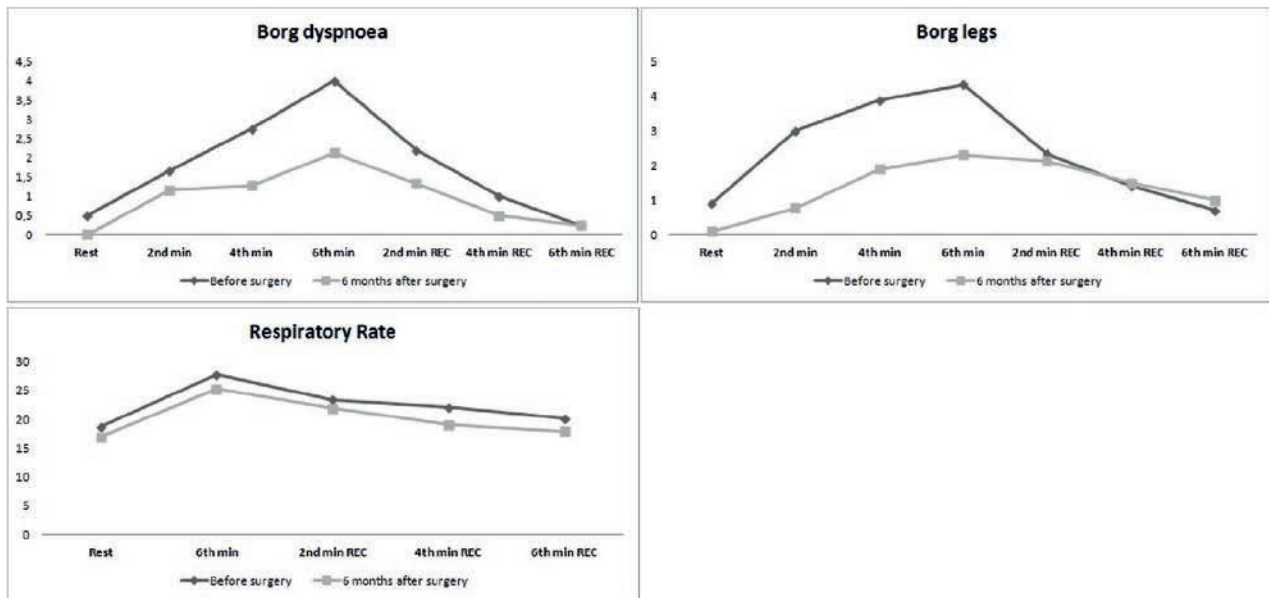


Figure 3. Performance of cardiorespiratory variables during the 6MWT

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.⁽¹⁷⁾ In addition, the decrease in sympathetic hyper-activation as a result of the decrease in leptin levels⁽¹⁸⁾ and the decrease in chronic intra-abdominal hypertension characteristic of morbid obesity,⁽¹⁹⁾ 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 Sherril⁽¹¹⁾.

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.^(6,20)

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.⁽²¹⁾ The literature shows that the majority of the weight loss occurs within the first 6 months,⁽²²⁾ and hence the extra 2 months for the second evaluation may have led 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.⁽²³⁾ 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,⁽²⁴⁻²⁷⁾ because of the metabolic demand increased by the extra-muscular work necessary to compensate the excess of body mass,⁽²⁸⁾ stimulate the sedentary lifestyle of these patients.⁽²⁹⁾ 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.⁽⁸⁾, in which only total scores higher than eight feature an active lifestyle.⁽³⁰⁾

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.⁽³¹⁾ In the present study the reduction of SatO₂ during 6MWT and recovery did not exceed 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,⁽³²⁾ 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.⁽³³⁾ 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.⁽³⁴⁾ 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 orientation of the physical activity, in order to make it possible to identify greater effects on the cardiorespiratory variables during exercise as a result of bariatric surgery.

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