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Original Article

WEIGHT LOSS AND CARDIAC PERFORMANCE

Emagrecimento e desempenho cardíaco

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ABSTRACT - ***Background*** - Cardiovascular diseases are the most frequent complications associated with obesity. The weight loss determine blood pressure decrease and improvement in parameters of lipid and glucose levels. Weight loss and maintenance reduce the risk factors for cardiovascular disease, making reversible cardiac changes resulting from obesity. ***Aim*** - To evaluate the effect of weight loss on physical capacity and the structural and functional heart of obese patients undergoing to bariatric surgery. ***Methods*** - Forty-three patients who underwent gastric Roux-en-Y bypass, were analyzed by ECG, and echocardiography preoperatively and one year after the bypass. Statistical analysis used the Wilcoxon and Student t test, Shapiro-Wilk test with a significance level of 5%. ***Results*** - The weight decreased from 116.5 kg to 21.5 ± 15.9 ± 80 kg, BMI of 41.8 kg/m 2 ± 4.4 to 28.4 kg/m 2 ± 3.8, heart rate decreased from 77.9 ± 9.6 bpm to 70.9 ± 7.8 bpm, systolic pressure of 130 ± 20 mmHg to 120 mmHg ± 10, diastolic 80 mmHg ± 10 mmHg to 80 ± 0. The exercise test showed increases in distance traveled of 378.9 m ± 126.5 m to 140.4 ± 595m; coefficient in metabolic equivalents (METs) from 6.7 ± 2.4 ml O 2 / kg / min to 8.3 ± 2.6 ml O 2 / kg / min, oxygen consumption (VO 2) 23.1 ± 8.4 to 10.3 ± 30. The echocardiogram showed a reduction in the interventricular septum of 12 mm to 10 mm ± 2 ± 1; posterior wall of 11 mm to 10 mm ± 2 ± 1; ventricular mass of 273 ± 85 g to 216g ± 60. There was improvement in diastolic function with increase in E '/ A'e E / A and ejection fraction with an increase of 70.2% ± 7.2 to 72.9 ± 6.4%. ***Conclusion*** - Obese patients undergoing bariatric surgery showed improvement in physical capacity and in the structure/functioning of the heart.

HEADINGS - Obesity. Bariatric surgery. Ergometry. Echocardiography.

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RESUMO – ***Racional*** - As doenças cardiovasculares representam as complicações mais frequentemente associadas à obesidade. O emagrecimento determina diminuição da pressão arterial e melhora nos parâmetros dos lipídeos e glicose séricos. A perda de peso e sua manutenção reduzem os fatores de risco para doenças cardiovasculares, tornando, reversíveis as alterações cardíacas decorrentes da obesidade. ***Objetivo*** - Avaliar o efeito da perda de peso sobre a capacidade física e as alterações estruturais e funcionais do coração de obesos submetidos à procedimento cirúrgico bariátrico. ***Métodos*** – Quarenta e três pacientes submetidos à derivação gástrica em Y-de-Roux, foram analisados por eletrocardiograma, teste ergométrico e ecodopplercardiograma no pré-operatório e um ano após a derivação. Na análise estatística utilizaram-se os testes de Wilcoxon, t de Student, Shapiro-Wilk com nível de significância de 5%. ***Resultados*** - O peso diminuiu de 116,5 kg ± 21,5 para 80 kg ± 15,9; o IMC de 41,8kg/m2 ± 4,4 para 28,4kg/m2 ± 3,8; a frequência cardíaca reduziu de 77,9 bpm ± 9,6 para 70,9bpm ± 7,8; a pressão sistólica de 130 mmHg ± 20 para 120mmHg ± 10; a diastólica de 80 mmHg ± 10 para 80 mmHg ± 0. O teste ergométrico mostrou aumentos na distância percorrida de 378,9m ± 126,5m para 595m ± 140,4; no coeficiente metabólico (MET) de 6,7 ± 2,4 ml de O2/kg/min para 8,3 ± 2,6ml de O2/kg/min; no consumo de oxigênio (VO2) de 23,1 ± 8,4 para 30 ± 10,3. O ecodopplercardiograma mostrou redução no septo interventricular de 12 mm ± 2 para 10 mm ± 1; parede posterior de 11 mm ± 2 para 10 mm ± 1; massa ventricular de 273 g ± 85 para 216g ± 60. Houve melhora na função diastólica com aumento na relação E'/A'e E/A e da fração de ejeção com elevação de 70,2% ± 7,2 para 72,9% ± 6,4. ***Conclusão*** - Obesos submetidos à cirurgia bariátrica apresentaram melhora na capacidade física e melhora estrutural e funcional do coração.

DESCRITORES - Obesidade. Cirurgia bariátrica. Ergometria. Ecocardiografia.

INTRODUCTION

Excess weight increases the risk of developing diseases such as hypertension, diabetes, dyslipidemia, coronary heart disease, stroke and others. Cardiovascular diseases are the most frequent complications associated with obesity[20].

The weight loss determine blood pressure decrease and improvement in parameters of lipid and glucose levels[4]. Weight loss and maintenance reduce the risk factors for cardiovascular disease, making reversible cardiac changes secondary to obesity[19].

Chiew et al.[6] showed cardiac abnormalities secondary to obesity in ventricular mass and tissue without answering if these changes disappears after weight loss.

The aim of this study was to evaluate anatomofunctional changes in class III obese heart undergoing bariatric surgery through anthropometric examinations, electrocardiogram, echocardiogram and exercise tests, comparing the results before and after the operation.

METHOD

Was conducted observational, longitudinal, analytical, prospective cohort design configuring single arm. The sampling technique was kind of convenience, enrolled consecutively. The sample consisted of 44 obese. One patient was lost on follow-up. There were no deaths. There was a prevalence of obesity class III with 33 individuals (76.7%).

Was evaluated preoperatively and one year after surgery, 43 obese adults, mean age 35.9 ± 12.2 years, 31 women (72.1%) and 12 men (27.9%) undergoing gastric bypass in Roux-en-Y, by the same surgical team during the year 2007. The selection of patients for surgical treatment followed the criteria proposed by the National Institute of Health, 1991, adopted by the Brazilian Society for Bariatric and Metabolic Surgery.

Exclusion criteria were the inability to walk on the treadmill and no echocardiographic window. No patient was excluded. Patients were included after having signed an informed consent form. The study was approved by the Ethics in Research Involving Human Subjects at the State University of Londrina, No. 234/08.

The protocol included preoperatively: clinical evaluation, measurements of blood pressure, weight, height, body mass index, echocardiogram, electrocardiogram and treadmill stress test computed. After the operation the patients were reassessed by the same examiner, using the same equipment and techniques used preoperatively. By the electrocardiogram were evaluated left atrial and left ventricular hypertrophy. The exercise test was performed on a computed treadmill by analyzing the physical capacity, oxygen consumption (VO^2 max) and metabolic ratio (MET).

Transthoracic echocardiography was performed using digital echocardiographic transducer with 2-4 MHz. Data interpretation was done through qualitative and quantitative analysis of two dimensional echocardiography, pulsed, continuous and tissue, and color flow mapping. Interventricular septum, posterior wall and ejection fraction were measured as far as the mass of the left ventricle.

Doppler measurements were made on three consecutive cycles, calculating their average. The evaluation of left ventricular diastolic function was performed by analysis of transmitral flow pulsed Doppler, with the evaluation of the peak velocities of E and A waves, E / A and also the wave tissue Doppler E 'and A' and with E '/ A'

The database was typed in an Excel spreadsheet and statistical analysis were conducted using SAS (Statistical Analysis System) version 9.1. The level of significance for statistical tests was 5% (0.05). Categorical variables were descriptively presented in tables containing absolute and relative frequencies. The continuous quantitative variables with normal distribution were presented descriptively as mean and standard deviation, while the variables with non-normal distribution with median and interquartile range. The differences between the measurement before and after the intervention were analyzed by Student t test for paired samples in normal distribution and the Wilcoxon test for two dependent samples, when distribution was not normal. Normality of variables was assessed by Shapiro-Wilk.

RESULTS

The levels of systolic blood pressure, diastolic blood pressure and heart rate before and after operation are shown in Table 1.

Preoperatively, four obese (9.3%) had left atrial enlargement on the electrocardiogram and a year after the operation only two remained obese with this change (4.6%) with non-significant reduction (p = 0.1573) this criterion.

The distance traveled, the metabolic ratio and oxygen consumption before and after surgery are shown in Table 2.

The data relating to the interventricular septum (normal up to 10 mm), posterior wall (normal up to 10 mm), left ventricular mass (upper limit of normal for men is 294 g and 198 g for women)[14], ejection fraction, E wave A wave, E / A are shown in Table 3. This table also shows the analysis with tissue Doppler E 'wave, wave A', E '/ A' pre-and postoperatively.

TABLE 1 - Variables of 43 obese patients in the pre and postoperative periods

Variable	Statistics	Before	After	Difference	Test (p value)
Age	Mean (SD)	35,9 (12,2)			
Weight	Mean (SD)	116,5 (21,5)	80 (15,9)	-36,5 (10,5)	T=-22,8(<0,001)
BMI	Mean (SD)	41,8 (4,4)	28,4 (3,8)	-13,4 (3,6)	T=-24,8(<0,001)
PAS	Median (interquartile range)	130 (20)	120 (10)	-10 (10)	S=-138,5(<0,001)
PAD	Median (interquartile range)	80 (10)	80 (0)	0 (10)	S=-116,5(>0,05)
FC	Mean (SD)	77,9 (9,6)	70,9 (7,8)	-7,0 (8,0)	T=-5,73(<0,001)

T = Student t-test for two dependent samples. S = Wilcoxon test for two dependent samples. BMI = body mass index. PAS = systolic blood pressure. PAD = diastolic blood pressure. FC = heart rate.

TABLE 2 - Variables of the treadmill stress test in 43 obese patients in the pre and postoperative periods

Variable	Statistics	Before	After	Difference	Test (p value)
DP	Mean (SD)	378,9 (126,5)	595 (140,4)	216,1 (117,2)	T=12,1(<0,001)
MET	Median (interquartile range)	6,7 (2,4)	8,3 (2,6)	1,7 (1,1)	S=473(<0,001)
VO^2	Median (interquartile range)	23,1 (8,4)	30 (10,3)	5,9 (5,5)	T=473(<0,001)

T = Student t test for two dependent samples. S = Wilcoxon test for two dependent samples. DP = distance traveled. MET = metabolic ratio. VO2 = oxygen consumption.

DISCUSSION

Obesity causes changes in cardiac structure and function. The increase in blood volume creates a state of high cardiac output that can lead to dilation and left ventricular hypertrophy and in some cases the right ventricle. As a result of these changes may appear systolic and diastolic dysfunction, disorders known as cardiomyopathy of obesity.

Constant elevation of blood pressure level in obese patients are associated with lesions in the heart, blood vessels and kidneys. At the heart can be observed diastolic dysfunction, characterized by decreased filling and dynamic relaxation and systolic, with concentric or eccentric hypertrophy. Ventricular hypertrophy is worsened when obesity and hypertension coexist, increasing the risk of heart failure[15].

Hypertension is present in 25% to 55% of obese class III. In this study 16 patients (37%) were hypertensive before the operation and only two (4.6%) after. Obesity class III, which predominated in this sample, increases the risk of hypertension in up to 16 times[12]. In this study, there was a 7.7% reduction in systolic blood pressure without significant changes in diastolic blood pressure. The patients had reduced

TABLE 3 - Variables of Doppler echocardiography in 43 obese patients in the pre and postoperative periods

Variable	Statistics	Before	After	Difference	Test (p value)
SEPTUM	Median (interquartile range)	12 (2)	10 (1)	-2 (2)	S=-390 (<0,001)
PP	Median (interquartile range)	11 (2)	10 (1)	-1 (1)	S=-289,5 (<0,001)
FE	Mean (SD)	70,2 (7,2)	72,9 (6,4)	2,7 (5,6)	T=3,13 (<0,001)
MASS	Median (interquartile range)	273 (85)	216 (60)	-54 (74)	S=-413,5 (<0,001)
E '	Median (interquartile range)	0,66 (0,13)	0,72 (0,35)	-0,02 (0,07)	S=-68,5 (0,326)
A '	Median (interquartile range)	0,58 (0,18)	0,50 (0,19)	-0,04 (0,09)	S=-404 (<0,001)
E	Mean (SD)	0,73 (0,09)	0,71 (0,07)	-0,54 (0,07)	T=-1,21 (0,235)
A	Median (interquartile range)	0,65 (0,20)	0,61 (0,13)	-0,03 (0,07)	S=-324 (<0,001)
E '/ A'	Median (interquartile range)	1,15 (0,24)	1,20 (0,41)	0,03 (0,27)	T=284,5 (<0,001)
E / A	Median (interquartile range)	0,80 (0,22)	1,01 (0,28)	0,04 (0,13)	S=283,5 (<0,001)

T = Student t-test for two dependent samples. S = Wilcoxon test for two dependent samples. PP = posterior wall. FE = ejection fraction. E '= E tissue wave'. A '= A wave tissue'. E = E wave A = wave A. E '/ A' = wave ratio E '/ A'. E / A wave ratio = E / A.

heart rate by 9% compared to preoperative values, probably due to decreased blood volume and the improvement in systolic and diastolic functions.

It was found as the only electrocardiographic change, left atrial enlargement with no significant differences between pre and postoperative period.

The aerobic capacity presented markedly decreased preoperatively. The lower exercise tolerance was influenced by obesity. Before the operation, patients had early fatigue, reflecting poor cardiopulmonary performance due to excess weight and sedentary lifestyle[9]. After, better performance was achieved in exercise testing when was analyzed their physical capacity in relation to distance traveled, oxygen consumption and metabolic coefficient. Significant improvement happened in all parameters analyzed after weight loss. The metabolic ratio (MET) rose to 24% postoperatively and oxygen consumption increased up to 29.9%. According to Roger et al.[18] for each MET increased in cardiorespiratory fitness, there is a reduction of 25% of cardiovascular sudden death, myocardial infarction and heart failure.

Studies that measured peak oxygen consumption (VO^2) during the conventional stress test showed that this test was a strong predictor of cardiovascular mortality[11]. This study used the exercise test without spirometry, which is an indirect method for evaluation, but with acceptable results[2]. Few studies[8] involving cardiac ultrasound and changes in exercise tests

before and after bariatric surgery - probably due to technical difficulties in its implementation -, confirm the importance of this paper to demonstrate the benefits of weight reduction with bariatric surgery, improving exercise tolerance with reduction of overload and diastolic dysfunction.

Class III obesity is associated with increased left ventricular mass, with lower systolic function and significant worsening of the left ventricular diastolic function. Dilated cardiomyopathy is the leading cause of sudden death in the morbidly obese (caused mainly by arrhythmias), characterized by cardiomegaly, left ventricular dilatation and hypertrophy of cardiac muscle fibers[3].

The weight decreased along with blood pressure, provided by the Doppler analysis, reduction of diastolic ventricular septal thickness, posterior wall and left ventricular mass, improving the diastolic and systolic function.

Echocardiography is currently the most widely used method for diagnosis of left ventricular hypertrophy. This examination has also been applied in the evaluation of systolic and diastolic functions of left ventricle in obese[7].

Echocardiographic studies evaluating obese have been rarely described, probably due to the operational difficulty of the exam with this group of individuals that commonly show limited echocardiographic window.

Cunha et al.[17] evaluated 23 obese pre and post-bariatric surgery by echocardiography and concluded that with the decrease in weight, there was reduction in the interventricular septum, posterior wall and left ventricular mass and improved systolic function and left ventricular diastolic, but they didn´t use exercise testing. In this study there was a decrease of 16.7% of the diameter of the interventricular septum and 9.1% of the posterior wall of the left ventricle, reducing hypertrophy with consequent improvement in left ventricular systolic function assessed by their ejection fraction.There was a 3.8% improvement in ejection fraction postoperatively.

Initial epidemiological studies of cardiac patients functional class III or IV show that diastolic dysfunction is responsible for approximately 50% of cases of decompensated heart failure[5]. Similar to what occurs in heart failure and multiple causes are involved in diastolic dysfunction, especially hypertension, coronary artery disease, diabetes mellitus, atrial fibrillation, obesity and senility[13,16]. Obesity increases the risk of diastolic heart failure because it is often associated with hypertension and increased left ventricular mass. Echocardiography has high sensitivity and specificity for detecting diastolic dysfunction through changes in the patterns of velocity of waves E and A. The left ventricular diastolic function was assessed by Doppler transmitral E and A waves and their E / A, where there has been improvement in the degree of left ventricular relaxation (diastolic function) with increasing E / A ratio at 26.2 %. It was also used tissue Doppler waves E 'and A' and its relation E '/ A' which showed an increase of 4.3% with the higher standard of left ventricular relaxation.

The benefit of diastolic function due to weight reduction has been documented[10] and its importance is reflected in better muscle relaxation of the left ventricle with global improvement in contractility of the same.

Left ventricular mass was increased in 41 patients (95.3%) preoperatively, postoperatively only 22 patients (51.2%) had it, with significant reduction in 20.9%.

The weight decrease determined by the operation may not be the only factor responsible for the improvement of cardiac structure and function. Its known that the operation presents humoral changes and these substances may have action on the heart. It must be also considered that the improvement in cardiac function may be due to other factors than just the weight decrease as lifestyle and healthier eating.

This research has limitations on the number of patients studied, but if other studies confirm these findings, it may indicate operation based on the findings of structural heart, independent of BMI.

CONCLUSIONS

The obese patients one year after bariatric surgery had: reduction in systolic blood pressure and heart rate; reduction of hypertrophy and left ventricular mass; improvement in diastolic and systolic function of left ventricle; improvement in cardiopulmonary capacity in relation to distance traveled, to oxygen consumption and to metabolic coefficient.

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