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Research Article

Study of body composition, physiological variables in Grade III obese submitted to arm ergometer test

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Abstract

Introduction: Number of obese people is growing on a daily basis in Brazil, including morbid obese ones, but there is still a lack of studies with this subject. Due to this, the main goal of this study was to identify body profile, physiological variables behavior and oxygen consumption in grade III obese women, submitted to an ergospirometric test in arm ergometer.

Method: Take part in this study, thirteen (13) female grade III obese patients between 20 and 40 years. They were submitted to an electric bioimpedance test for body composition measurement and an Ergospirometric test in arm ergometer for oxygen consumption, heart rate, and oxygen saturation, systolic and diastolic arterial pressure, resting and after exercises, analysis.

Results: The patients revealed a BMI of 46.5±3.81 kg/m², 51.9±1.59% of body fat percentage. The patients reached 168.2±4.57bpm of heart rate, didn't make any hypertensive response to the effort reaching an arterial pressure of 171.1±22.15mmHg x 87.5±4.18mmHg. Oxygen saturation was 98±0.71% and oxygen consumption peak was, also in average, 12.3±2.75ml.kg.min^{-1}.

Conclusion: It was verified that there was no oxygen saturation drop nor hypertensive response and all of the patients reached the maximum heart rate.

Introduction

Overweight occurs in more than a billion people around the world, which 600 million are obese [1]. World Health Organization (OHS) defines obesity as excessive accumulation of adipose tissue with health implications, [2] with multifactorial etiology, [2-4] and can be classified as several grades according to BMI´s values over 40kg/m² [3,5,6]. The importance of this study about obesity relates to its consequences in other diseases development, such as: diabetes mellitus type II; arterial hypertension;

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dyslipidemia; chronic obstructive pulmonary disease; heart disease and certain cancers [4,6-9].

These diseases above mentioned can induce modifications in physiological variables. Oxygen consumption (VO_2) is an important variable to estimate the quantity of captured oxygen (O_2), transported and metabolized to energy production in a time unit during an effort test [10]. Oxygen peripheral saturation (SpO_2) is a great indicator of abnormal gas exchange [11,12] and grade III obesity usually compromises cardiovascular system.

Blood Pressure (BP) characterized by blood flow force over arteries [13] in obese people, can show changes, since skin excess has a strong correlation to higher blood pressure [14]. Heart Rate (HR), which reflects the number of heart beats in a time gap [13], has a linear rise during effort, reaching a maximum that may vary, inversely with the age [15].

Ergosperimetry has, as indication, disease monitoring, treatment evolution, disability score, among others and the Ergosperimetric Test in upper limbs´ cycle ergometer has been studied since post war period in paraplegic [16] and some authors [16-18] suggest also to patients with walking difficulties, amputees and heart diseases ones.

Due to the lack of literature involving grade III obese patients, the main goal of this study is to identify the body profile, the behave of physiological variables and oxygen consumption in grade III obese women, submitted to a ergosperimetric test in arm ergometer.

Materials and Methods

Sample

The sample was composing of thirteen grade III female patients that were recruited from the Bariatric Surgery Program of the Clementino Fraga Filho University Hospital´s in 2015, and they were followed up by a multidisciplinary staff. Only participated in the maximal exercise test in arm ergometer those patients referred by medical staff and met the inclusion criteria: having a BMI between 40 and 60 kg/m^2, sedentary and aged between 20 and 40 years (average age of 34.7±5.07).

Patients who used beta-blockers and insulin, chronic obstructive pulmonary disease, pregnant women, who used pace markers, who had osteoarticular problems that would present exercise and who had already undergone bariatric surgery were excluded. All patients were instructed about the test and that participation was voluntary and with this, only those who signed an Informed and Free Consent Term, according to 196/96 resolution of Brazil´s National Council of Health, were allowed to participate. Throughout the test there was a cardiologist accompanying through an electrocardiogram and this research did not receive from companies and government funding.

The research was of descriptive nature and its transversal analysis, where it was analyzed quantitative parameters about people and situations [19], having Grade III obesity as independent variable and body mass index (BMI), body fat percentage (%BF), heart rate (HR),oxygen saturation(SpO_2), systolic blood pressure (SBP), diastolic blood pressure (DBP) and oxygen consumption (VO_2) as dependent ones.

Instruments and procedures

For body composition measurement, it was used a multipolar bioimpedance balance, from INBODY® model 230. During evaluation, patients were barefoot, wearing the minimum clothing possible, without any metallic objects. Besides, patients were previously instructed to follow a three hours fasting protocol and not drink any alcohol nor caffeine for twelve hours, water for four hours and intense physical exercise for 12 hours before the measurement.

For ergospirometric evaluation, an interdisciplinary flow chart from Obesity and Bariatric Surgery´s Program was followed, through previous medical approach and subsequent release for test, which was attended by a cardiologist that analyzed electrocardiographic records by an electrocardiograph from TEB ECGPC of twelve derivations with positioning proposed by Mason and Likar [20]. The room was prepared to guarantee calorimeter´s recommendations, from CAREFUSION, mode VMax 29N Encore, those are, minimum noise ambient and not more than three evaluators, with temperature ranging from 20 to 24 degrees and humidity between 50 and 60%. In addition, an arm ergometer from TECHNOGYM model EXCITE PRO.

The systolic and diastolic blood pressure were measured with a stethoscope from GLICOMED, model CARDIOLOGY and an aneroid sphygmomanometer from GLICOMED, on the right arm of the patient with an 33-44 cm clamp, specific for obese people. The SpO_2 was checked through a pulse oximetry with the aid of a finger oximeter from CONTEC on left index finger at the same time that the arterial pressure is measured on the other arm by other evaluator.

Protocol

The protocol applied was the ramp, being used the formula to leg ergometer VO_2=40.31-(0.41 x age) (21), rectifying for upper limbs (less 35% of maximum VO_2 estimated) considering the difference between the two ergometers [21]. The result was inserted in ACSM formula to calculate the maximum power ($W_{Máx}$) in arm ergometer $VO_{2máx}=W_{máx}$x18.36+ (weight x 3.5) [22]. After it was reduced 50% of maximum power, according to III guideline of the Brazilian Society of Cardiology for Cardiac Stress test [23]. For ramp´s preparation, it was subtracted 30W (minimum accepted by ergometer) from predicted maximum power and the rest was split by 10 (average time expected for the test), reaching to the number of increments by minute.

Patients were oriented to keep a rhythm between 70 and 90 rpm but the number of rotations did not affect the power. The variables HR, SpO_2, systolic and diastolic blood pressure were evaluated in 5 moments: during rest, just after the maximum effort, one, there and five minutes after the test. The calculation for expected maximum heart rate was through the formula $HR_{máx}$= 198-(0.42 x age) proposed by SHEFFIELD and Cols (1965). The criteria adopted for test classification as maximum was: R≥1, 1; heart rate equal or over 85% from maximum; and/or voluntary exhaustion [23]. The criteria for test interruption followed ACSM´s guideline to stress test, through absolute and relative indications.

This paper was approved by UFRJ´s Ethics Committee, in Rio de Janeiro, protocol number 12520413.6.0000.5257. For statistics, it was used a descriptive analysis, with measures of central tendency (average), minimum values, maximum and standard deviation.

Results

In the table 1 below, it is possible to analyze the patients´ body profile results, proving the relationship with the morbid obesity.

After observing that patients fit the study inclusion criteria, an ergospirometric test was made, verifying the heart rate, arterial pressure and SPO_2 in rest and in three other moments: 1, 3 and 5 minutes after physical exercise. It is also possible to observe the aerobic maximum power expected and reached in the test, see table 2.

Table 1: Body Profile from grade III obesity patients.

	Average	SD	Min	Max
Age (years)	34,7	5,07	25	40
Body Mass (kg)	118,3	17,76	92,6	151,6
Stature (m)	1,59	0,07	1,50	1,72
BMI (kg/m²)	46,5	3,81	40,3	53,5
% FM	51,9	1,50	50,1	55,5
% FFM	48,1	1,50	44,6	74,6
FM (kg)	61,4	9,55	47,4	77
MM (kg)	32,1	5,08	24,9	42,4

Data: BMI-Body Mass Index, %G-Percentage of the fat mass, %MLG-Percentage of the fat free mass, MG-Fat Mass, MM-Muscle Mass.

Table 2: Average Results, Standard Deviation, minimum and maximum of arterial pressure, heart rate, oxygen saturation, oxygen consumption and grade III obesity patient´s power at various times.

Variables	Average	Standard Deviation	Minimum	Maximum
Systolic Blood Pressure Resting	130,2	6,85	120,0	142,0
Diastolic Blood Pressure Resting	84,8	5,57	76,0	96,0
Systolic Blood Pressure Effort Max	171,1	22,15	150,0	210,0
Diastolic Blood Pressure Effort Max	87,5	4,18	80,0	94,0
Systolic Blood Pressure Recovery after 3'	139,9	12,28	120,0	160,0
Diastolic Blood Pressure Recovery after 3'	85,6	5,91	76,0	95,0
Systolic Blood Pressure Recovery after 5'	128,8	8,51	114,0	142,0
Diastolic Blood Pressure Recovery after 5'	85,1	4,94	80,0	92,0
Heart Rate Resting	83,7	10,2	65,0	97,0
Heart Rate Max Preview	183,4	2,13	181,2	187,5
Heart Rate Submaximum	155,9	1,81	154,0	159,4
Heart Rate Max Hit	168,2	14,5	145,0	193,0
Heart Rate Recovery 1’	124,8	16,8	102,0	159,0
Heart Rate Recovery 3’	108,9	13,2	96,0	144,0
Heart Rate Recovery 5’	105,9	11,7	93,0	136,0
Oxygen Saturation Resting	97,9	0,9	96,0	99,0
Oxygen Saturation Effort Max	98,0	0,7	96,0	99,0
Oxygen Saturation Recovery 1’	98,1	0,8	96,0	99,0
Oxygen Saturation Recovery 3’	98,0	0,7	97,0	99,0
Oxygen Saturation Recovery 5’	97,9	1,0	96,0	99,0
Volume of Oxygen Max Preview	17,0	1,3	15,5	19,5
Volume of Oxygen Peak	12,3	2,7	7,7	17,9
Power Rating Max Preview	115,4	22,8	83,5	152,2
Power Rating Expected	57,6	12,1	41,7	76,1
Power Rating Max Atingido	60,3	14,6	39,0	98,0

Data: SBP-Systolic Blood Pressure (mmHg), DBP-Diastolic Blood Pressure (mmHg), HR-Heart Rate (bpm), SPO_2-Oxygen Saturation in percentage (%), VO_2-Volume of Oxygen (ml/kg.min^{-1}),W-Power Rating (w).

VO_2 curve, like heart rate curve, increased with the rise of intensity in the effort. Patients reached an oxygen consumption peak of, in average, 12.3±2.75ml. Kg. min-1. The identification of maximum VO_2 is achieved when the increase of load doesn´t results in a change of VO_2 or when a plateau appears. If the criterion is not obtained, it is used the term VO_{2peak} [24].

Discussion

First step to evaluate the patient´s profile is to analyze her body composition, through electric bioimpedance, revealing a fat percentage according to this population, due to physical inactivity characteristics, key factors to adipose tissue´s accumulation and muscle mass´s reduction [2,3]. Besides, grade III obesity introduces several modifications to body composition, in comparison to other grades, such as bigger total water accumulation, intra and extracellular, that may incite modifications in the lean mass percentage.

It was observed similar results in fat percentage in morbid obese women, in other words, a high percentage (55%) and a positive correlation between this parameter, through electric bioimpedance, and BMI, waist circumference and biochemical variables [25].

Several factors influence in VO_{2peak} values like the type of exercise, gender, age, body composition and physical activities level. Predicted VO_2 [22] to arm ergometer was, in average, 17±1.35ml.kg.min^{-1}, higher than the one found in the test. This difference may be related to the obesity grade, physical inactivity and peripheral fatigue. The modifications in the end of the curve might have happened because of biomechanical inefficiency close to maximum effort. Evidences suggest that peripheral fatigue and local muscular perfusion might be limiting factors to reach VO_{2peak} value in upper limbs´ exercise, leading to a intramuscular tension and blood flow rise, limiting VO_2 [26].

All patients presented a very low VO_2, according to the classification proposed by American Heart Associtation through Ergonometry National Consensus (1995), which is understandable because of excessive weight, physical inactivity, low muscle mass and test specificity, besides this, obese people possess relative VO_2 is lower than in eutrophic ones [27,28]. Fornitano [6] compared 290 grade III obese patients with 327 eutrophic ones, through an ergospirometric test in a treadmill and also find very low values of VO_2 in the obese group (16.4ml.kg.min^{-1}) showing that obesity negatively interfered in effort tolerance. Salvadori et al. [29], studied cardiopulmonary performance in 11 obese young patients and other 10 young eutrophic through a lower limbs´ ergometer cycle and verified a lower power and VO_2 in the obese, concluding that lower tolerance to the effort is related to reduce supply of oxygen to the muscles and to a poorer cardiac performance.

Most of the patients did not reached the maximum heart rate predicted on the test, being able to be related to the upper limbs´ fatigue, since there is a smaller amount of muscular mass involved when compared to lower limbs´ ergometric, generating a smaller cardiac debit and heart rate. Related to the observed after effort results, there was a heart rate reduction of more than 20% (43.4±8.06bpm) in all patients, in the first minute of rest, in comparison to the maximum heart rate. This reduction allows to infer cardiac vagal modulation, since reductions smaller than 12 bpm have association to a higher prevalence of mortality [30].

Pulmonary complications are very usual in obese patients, although BMI values and pulmonary function tests are not able to forecast these problems. Grade III obese people use to present restriction in gas exchange, with a low reduction in oxygen pressure and increase in alveolar-arterial oxygen difference. SpO_2 monitoring while effort may indicate an existing pulmonary disease and facilitate the diagnosis of dyspnea on exertion [31], since the demand imposed by the physical exercise increases ventilation and perfusion and decreases SpO_2 [32].

However in this study, it was not found a decrease in SpO_2 between repose and effort (97.9±0.95% e 98.1±0.86%), what can be related to the selection of young patients with not pulmonary commitment. Other authors investigated the pulmonary response to physical exercise in 92 young people, male and female, obese and not obese, through a prospective transversal study, concluding that SpO_2 values reduced while exercises in young obese. Leading to a conclusion that young obese presented pulmonary functions variation in rest and these changes were maintained while all exercise [33].

Regard heart rate during the maximum aerobic power test, there was a linear rise in this parameter, and also in VO_2, in all patients, due to cardiac debit increase and involved muscle mass [34]. Because when the exercise is initiated, the autonomic nervous system can elevate the venous return, incurring in a larger distension of the right ventricle to receive more blood volume, added to the tachycardia that follows and to the increase of cardiac debit [33].

Arm ergometer test usually causes an expressive increase in arterial pressure, since exercises involving minor muscular groups may favor vasoconstriction of other inactive muscles [35]. There is no established limit to the increase of systolic blood pressure, but values higher than 250 mmHg can be observed [35], in this research there was no patient with systolic blood pressure higher than 180 mmHg and diastolic blood pressure over 15 mmHg).

Compare, through a ergospyrometric test in a treadmill, morbid obese patients with eutrophics ones and verified that systolic arterial pressure increased in both groups, but reached higher values in the obese, and diastolic arterial pressure presented a small increase with no difference between the groups [28]. Described the rise of average diastoliac arterial pressure while physical exercise performed upper limbs', suggesting a bigger isometric component, since while this effort the peripheral resistance is higher due to an increased catecholamine secretion and on the isometric contraction required to stabilize the trunk [16].

Conclusion

It can be concluded that the maximal stress test in arm cycle ergometer is a reliable and useful method for the cardiac evaluation for morbid obese women. With this, it can be another tool for the risk stratification for bariatric surgery and the reliable prescription of an individualized program of aerobic physical exercises.

It is recommended to do another study, with the same methods, for male patients and adults with BMI over 60kg/m^2. Besides, it is important to monitor the arterial pressure and oxygen saturation while effort.

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