Journal of
HYPERTENSION RESEARCH
www.hypertens.org/jhr

Original Article
J Hypertens Res (2020) 6(1):23–28

The importance of cardiac rehabilitation for chronic hypertensive patients with coronary artery disease

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Received: December 2, 2019, Accepted: January 20, 2020

Abstract

Arterial chronic hypertension represents a very important risk factor regarding the development of atherosclerosis which in turn can progress to acute coronary syndromes. Cardiopulmonary exercise testing (CPET) has become a very important investigation in the assessment of exercise capacity and intensity of the patients who are performing cardiac rehabilitation. The purpose of our study was to objectify the relationships between the parameters of CPET and the echocardiographic parameters after the cardiovascular rehabilitation. We found a significant increase in oxygen consumption (VO2) values, anaerobic threshold, effort capacity and maximum heart rate and an improvement in the systolic function, marking a reduced cardiovascular risk.

Keywords: cardiovascular rehabilitation, hypertension, CPET, coronary disease

Introduction

Arterial chronic hypertension (HTN) is one of the established cardiovascular risk factors for development of atherosclerosis [1] and an increased incidence of coronary artery disease [2], peripheral vascular disease [3], cerebrovascular disease and chronic renal disease [4]. It also represents an important risk factor for heart failure, myocardial infarction, stroke, and cardiovascular death [5,6].

Arterial hypertension represents one of the main factors that leads to atherogenesis and the development of vulnerable plaques whose instability or rupture (which in turn results in thrombosis and vessel occlusions) are responsible for the development of acute coronary syndromes (ACS) [2].

In GUSTO-1 trial that included 41021 patients with STEMI who presented to the hospital within 6 hours of symptom onset were randomized to receive different thrombolytic regimens: in this population the prevalence of a history of previous hypertension was 38.1% (15544 of 41021) [7]. In the

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RO-STEMI study that went from 1997 to 2009, that included 19510 patients with STEMI, the prevalence of previous hypertension was 52,3% [8] while in the GISSI-2 (Gruppo Italiano per lo Studio della Streptochinasi nell'Infarto) which included 20491 patients with STEMI randomized to a 2×2 protocol of thrombolysis, a history of HTN was present in about 35% of the whole population [9].

However, the prevalence of arterial hypertension in patients with acute myocardial infarction (AMI) has not been adequately investigated, since most of the data was obtained using studies performed in the prefibrinolytic era (when drugs like aspirin, statins, or beta-blockers were not included in the routine therapeutic list and interventional procedures were not available for a great number of cases) or from clinical trials where the characteristics found in the pacients differed considerably from those found in routine clinical practice.

All the more as of late, different investigations concentrated on patients with STEMI submitted to essential PCI [10,11] in which a past history of hypertension was available in a scope of 30–33%. The SYMPHONY trial [12] indicated a commonness of HTN in STEMI patients of over 50% (most likely because of various criteria of choice of the investigation populace), and an ongoing Spanish registry (PRIM-VAC) detailed a 46% predominance of hypertension in STEMI patients [13]. From every one of the registries and the information accessible up to now [2,14], hypertensive patients with STEMI have the following charatheristics: older, female, of non-white ethnicity, and having a higher predominance of comorbidities, for example, diabetes, hypercholesterolemia, incessant renal disappointment, history of cardiovascular disease, earlier myocardial infarction, and earlier myocardial revascularization (angioplasty and stent implantation or coronary artery bypass graft [15].

The Cardio-Pulmonary Exercise Test (CPET) has turned into a significant clinical examination in surveying effort capacity. It is an important instrument for both the diagnosis and prognosis of patients. It permits the assessment of all the systems required during exertion: respiratory, cardiovascular, haematopoietic, musculoskeletal and neuropsychic. The conclusive outcome is more precise than the individual estimation of these systems. Because of the probability of investigating respiratory gases, with the estimation of VO_2 max and threshold determination, CPET is the best quality level in direct evaluation of activity power and exercise limit [16,17,18].

Cardiovascular rehabilitation is vital in patients with coronary heart disease. It contains a lot of exercises required to impact the development of the disease and to offer patients with the best physical and state of mind, accepting a long haul exertion from both doctor and patient. The recuperation program incorporates a multidisciplinary group including a cardiologist, a physiotherapist, a nutritionist and a therapist, who will decide the time, intensity and frequency of the physical effort as indicated by the severity of the pathological process and the sequelae of the acute cardiovascular event [19,20,21].

Material and Methods

We conducted a prospective study that included 78 patients who were investigated at the Cardiovascular Recovery Clinic from Recovery Hospital of Ia□i, Romania. They were evaluated when initially admitted and 6 months later. Inclusion criteria consisted of a prior diagnosis of chronic arterial hypertension and one of the following: stable angina pectoris, chronic myocardial infarction or chronic ischemic cardiopathy no later than 3 months prior to admission. The Ethics Commission's approval was obtained and all the patients signed the participation consent before the study began.

Within the six months of cardiac rehabilitation, patients conducted endurance aerobic exercise at least five days a week. Each training session lasted between 30 and 60 minutes depending on physical condition and comorbidities, and was performed at a medium intensity. Each patient performed CPET initial assessment, being established the characteristics of the type of effort the patients needed to perform [8,9]. The features of the physical effort were frequency, exercise intensity for which we used Borg scale and the actual time of each session [10,11].

The parameters monitored in the study using the CPET were: VO_2, anaerobic threshold (AT), the cardiac frequency and the effort capacity.

VO_2 is the quantity of oxygen that the patient consumes during the test. At a certain point during exercise, VO_2 reaches a maximal value (VO_2 max) despite the fact that the patient continues the physical effort [12,13].

The anaerobic threshold estimated the occurrence of metabolic acidosis due to the inefficiency of the aerobic metabolism at muscle level. AT is obtained near the highest effort, making the transition to an anaerobic metabolism and the accumulation of lactic acid, AT is an indicator of the patient's physical condition and it is used in the diagnosis of a limitation to effort [14,15].

Maximum heart rate is important for the monitoring of heart rate response to effort. The maximum theoretical heart rate was calculated using the following approved formula: 220 - patient age [16].

The statistical analysis was performed using SPSS software, version 7.0. A value of p<0,05 was considered statistically significant. The correlations between variables were performed using Pearson r correlation coefficient.

Results

Our study included 78 patients, predominantly males (80.8%), with an average age of 59±9.08 years, ranging from 36 to 79 years. Out of the total number of patients, 33.33% had undergone coronarography and coronary artery stenting, 13.33% aortocoronary bypass and 53.33% were prescribed conservative treatment. The assessed cardiovascular risk factor was HTA, which was encountered in 93% of the patients. All patients underwent a 6-month cardiovascular rehabilitation program and then repeated the CPET.

We found a significant increase in VO_2 max values from 1250.07 ml/min to 1557.39 ml/min (p <0.01) (fig 1), as well as a significant improvement in the VO_2 max percentage from the theoretical value: 58% to 72% (p<0.01) (fig.2). Regarding the production of carbon dioxide during the CPET procedure there was also an increased value for the second test: 1407,53 ml/min to 1728 ml/min (p<0,01).

The value of the AT also showed a statistically significant increase (p <0.01), marking an improved

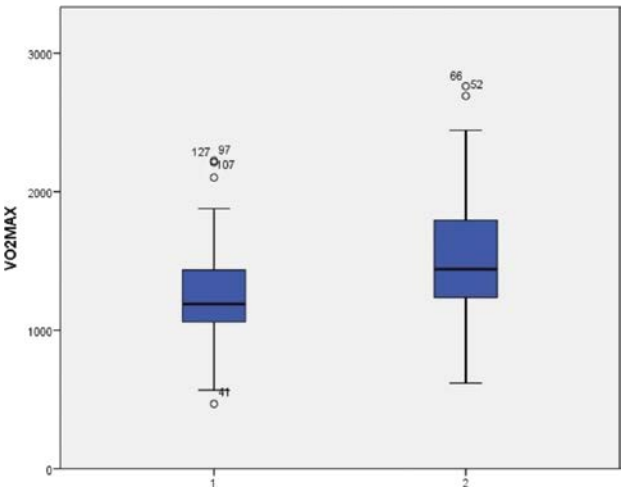

Figure 1 VO_2 max ml/min at initial and second evaluation.

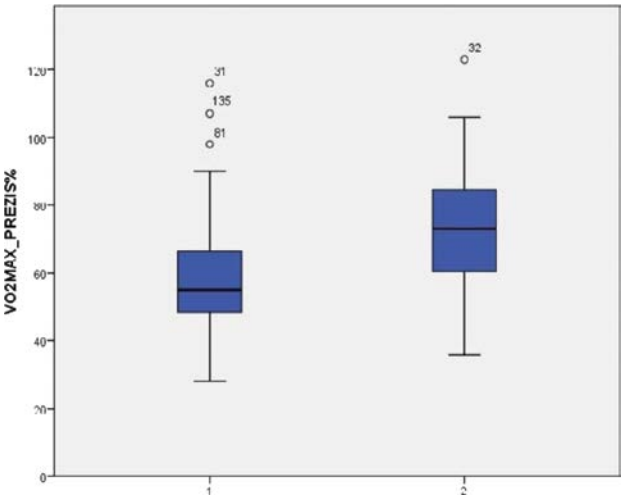

Figure 2 VO_2 max% from theoretical value at initial and second evalution.

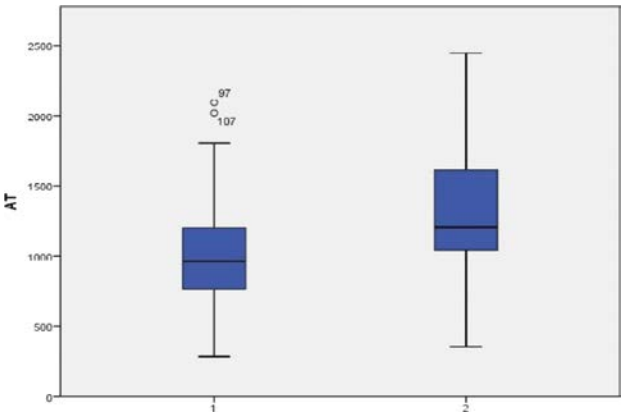

Figure 3 AT at intial and second evalution.

physical condition after the cardiovascular recovery program (fig.3).

The maximum effort capacity of the patients obtained from the predicted value for each individual improved (p <0.01) from 94.9 W to 112.1 W (p<0.01) (fig. 4), as well as the WATT max percentage from the theoretical value: 55.2% to 64.5% (p<0.01) (fig. 5).

The heart rate also presented a significant increased value (p<0.02) between the tests, from 68.9/min to 73.2/min (fig 6) as well as the oxygen pulse (p<0.01) from 12.3 ml/min/beat to 14.5 ml/min/beat (fig. 7).

The ejection fraction did not have an increased statistically significant value (p<0.07), but we observed a better result between the two tests 51.1% to 54.9%, while the mitral annular plane systolic excursion (MAPSE) had a relevant grow from 15.8 mm to 17.4 mm (p<0.03) (fig. 8).

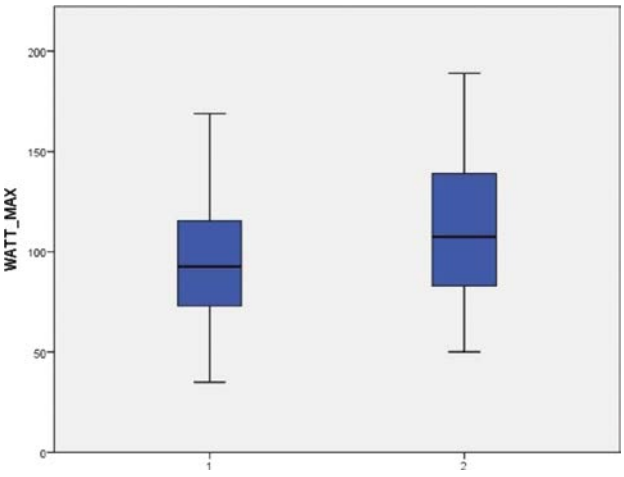

Figure 4 WATT max at initial and second evalution.

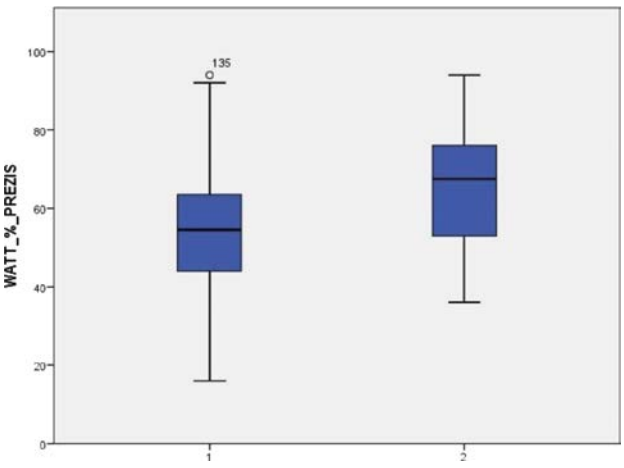

Figure 5 WATT max% from theoretical value at initial and second evalution.

Discussion and conclusions

In the study published by Popovic D., et al., which assessed cardiovascular recovery efficiency through cardiopulmonary exercise testing, was followed a

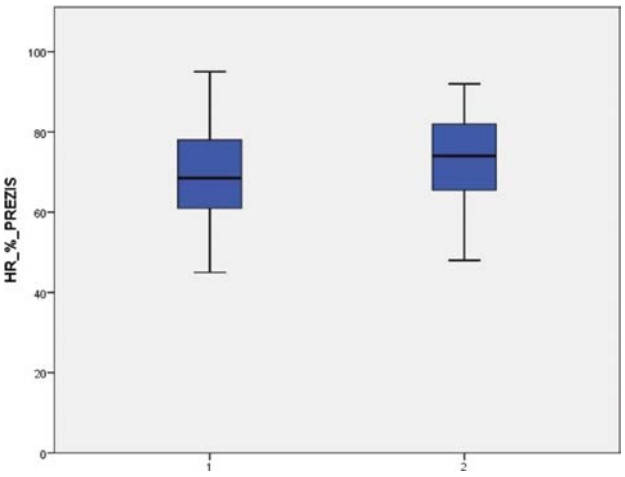

Figure 6 Heart rate at initial and second evalution.

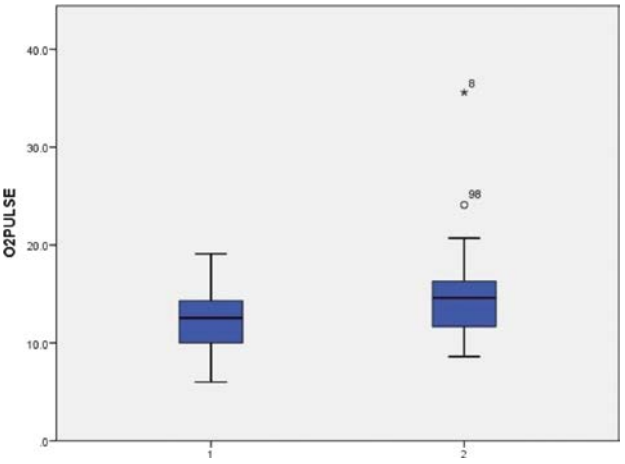

Figure 7 O_2 pulse at initial and second evalution.

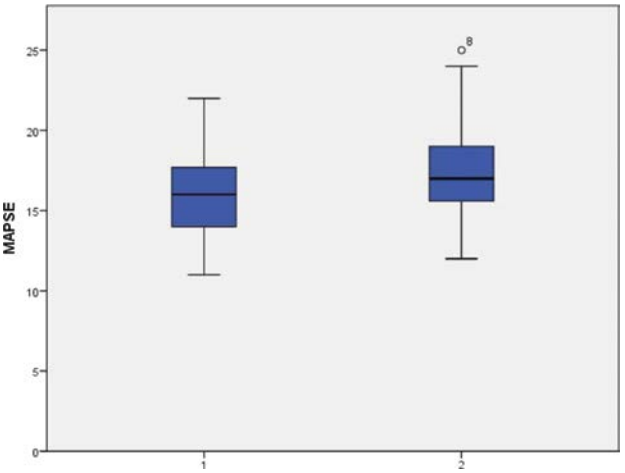

Figure 8 MAPSE at initial and second evalution.

Table 1. CPET parameters after 6 months of rehabilitation.

Variables	Mean 1	Std. deviation 1	Mean 2	Std. deviation 2	Sig. (2-tailed)
VO2 max	1250.07	340.18	1557.39	435.4	<0.001
VO2 max predicted	58	17	72	18	<0.001
VO2/kg/m2	13.11	3.3	16.5	4.7	<0.001
VCO2 max	1407.53	372.6	1728	453.6	<0.001
VCO2/kg/m2	14.27	3.7	17.59	4.6	<0.001
AT	999	359.4	1291.7	448.4	<0.01
WATT max	94.9	30.3	112.11	34.8	<0.002
WATT max predicted	55.2	15.5	64.5	14.7	<0.01
HR predicted	68.9	11.6	73.2	10.6	<0.022
FE	51.1	12.4	54.99	10.8	<0.07
FS	29.1	9.4	31.5	9	<0.16
TAPSE	24.9	5.3	26.1	5.2	<0.26
MAPSE	15.8	2.6	17.4	2.7	0.009
O2 pulse	12.3	2.8	14.5	4.1	<0.001

group of 142 patients, 23% women, who carried out between 3 and 6 months specific recovery programs after a coronary event. There was a significant increase ($p < 0.01$) of the main parameters of TECP (VO2max, anaerobic threshold, respiratory metabolic efficiency and effectiveness), results that are consistent with those obtained in our study [22].

In another study published by J. Lavie et al., which enrolled 235 patients out of which 72% performed percutaneous transluminal angioplasty, 19% aorto-coronary bypass and 28% myocardial infarction with conservatory treatment, they have carried out 3 months cardiac rehabilitation in which were followed major CV risk factors: lipid profile, BMI, hypertension and smoking and echocardiographic parameters. The results showed a significant decrease in LDL cholesterol as well as triglycerides, as well as increased values regarding the ejection fraction, TAPSE and MAPSE, results again confirm the values obtained in this study [23]

The enrollment of coronary artery disease patients in a cardiovascular rehabilitation program is of vital importance. A 6-month cardiovascular rehabilitation program improves lipid profile, CPET parameters and overall physical condition in subjects with angina pectoris, myocardial infarction or ischemic cardiomyopathy.

Conflict of interest

The authors confirm that there are no conflicts of interest

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