Cardiopulmonary Testing and Biochemical Profile of Coronary Patients Subject to Cardiovascular Recovery Programs

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Cardiopulmonary exercise testing (CPET) has become the golden standard 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 lipid profile after the cardiovascular rehabilitation. We found a significant increase in oxygen consumption (VO_2) values, anaerobic threshold, effort capacity and maximum heart rate and an improvement in the lipid profile, marking a reduced cardiovascular risk.

Keywords: cardiopulmonary testing, coronary patients, cardiac rehabilitation, lipid profile

The Cardio-Pulmonary Exercise Test (CPET) has become a very important clinical investigation in assessing effort capacity. It is a valuable tool for both the diagnosis and prognosis of patients. It allows the evaluation of all the systems involved during effort: pulmonary, cardiovascular, haematopoietic, musculoskeletal and neuropsychic. The final result is more accurate than the individual measurement of these functions. Due to the possibility of analyzing respiratory gases, with the measurement of VO_2 max and threshold determination, CPET is the gold standard in direct assessment of exercise intensity and exercise capacity [1-3].

Cardiovascular rehabilitation is of extreme importance in patients with coronary heart disease. It comprises a set of activities required to influence the evolutionary process of the disease and to provide patients with the best physical and mental condition, assuming a long-term effort from both physician and patient. The recovery program includes a multidisciplinary team consisting of a cardiologist, a physiotherapist, a nutritionist and a psychologist, who will determine the time, intensity and frequency of the effort according to the severity of the pathological process and the sequelae of the acute cardiovascular event [4-6].

Dyslipidemia is one of the major risk factors that require optimal control to reduce the risk of future cardiovascular ischemic events. Vergès (1998) *et al.* have demonstrated that patients with a history of coronary heart disease integrated into cardiovascular recovery programs showed a significant decrease in the lipid fractions under medical treatment compared to those who did not follow such programs [7].

The goal of the study was to objectify possible relationships between changes caused by cardiovascular rehabilitation on specific parameters of CPET and on the lipid profile.

Experimental part

Material and method

We conducted a prospective study that included 60 patients from urban and rural areas, who were investigated at the Cardiovascular Recovery Clinic from Recovery Hospital of Iasi, Romania. They were evaluated when initially admitted and 6 months later. Inclusion criteria consisted of a prior diagnosis of 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].

We analyzed lipid profile, including total cholesterol levels, LDL-cholesterol, HDL-cholesterol and triglycerides (TG). We defined dyslipidemia for values of total cholesterol > 200 mg/dL and/or LDL-cholesterol > 100 mg/dL and/or HDL-cholesterol < 35 mg/dL and/or use of lipid-lowering drugs [17-19].

The statistical analysis was performed using SPSS software, version 7.0. A value of $p<0.05$ was considered

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statistically significant. The correlations between variables were performed using Pearson r correlation coefficient.

Results and discussions

Our study included 60 patients, predominantly males (86.67%), with an average age of 58±9.08 years, ranging from 36 to 77 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 factors were: HTA in 66.7%, dyslipidemia in 76.7% and diabetes in 53.3% 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 1078.77 mL/min to 1342.5 mL/min ($p < 0.01$), as well as a significant improvement in the VO_2 max percentage from the theoretical value: 62.73 to 50.27% ($p<0.01$) (fig.1).

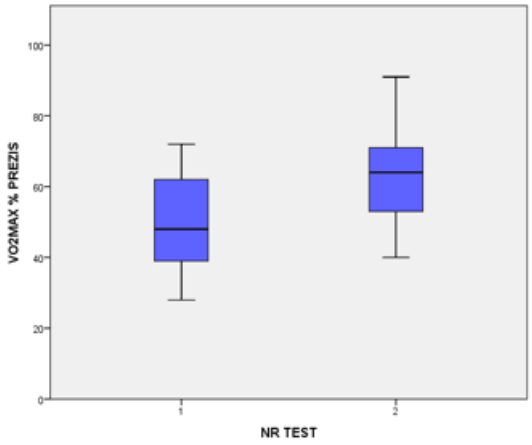

Fig. 1. VO_2 max % at initial and second evaluation

The value of the AT also showed a statistically significant increase ($p < 0.03$), marking an improved physical condition after the cardiovascular recovery program (fig.2).

The maximum effort capacity of the patients obtained from the predicted value for each individual improved ($p < 0.01$) from 49.77 W to 58.2 W.

The biochemical lipid profile had a favorable evolution under exercises and statin treatment ($p<0.02$), however no statistically significant change was observed regarding body mass index (BMI) ($p<0.22$) (fig.3-6).

Our results suggest that patients with coronary artery disease who undergo a 6-month cardiovascular rehabilitation program present a significant decrease in some of the major cardiovascular risk factors, especially lipid profile (table 2). Other authors have reported similar results in studies with 72 patients with a cardiovascular rehabilitation program that lasted as long as ours [20,21].

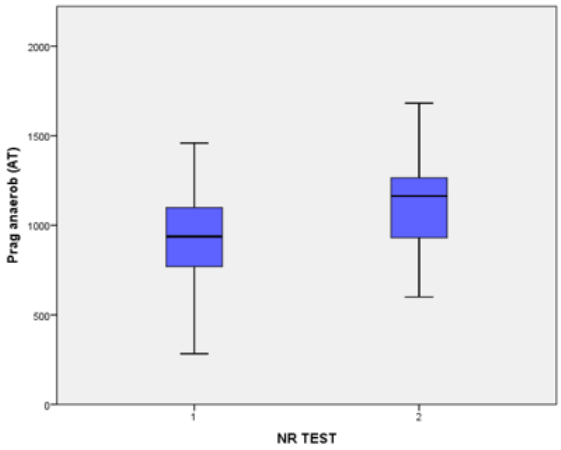

Fig. 2. AT at initial and second evaluation

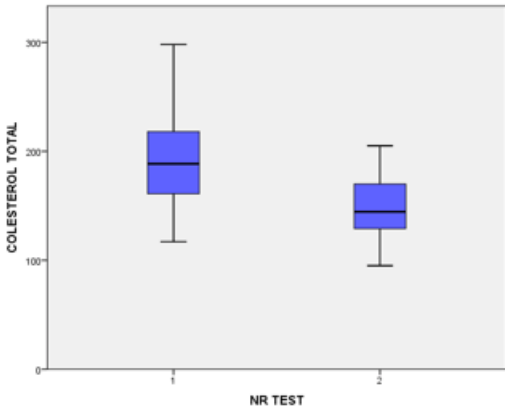

Fig. 3. Total cholesterol at initial and second evaluation

Other studies regarding cardiopulmonary exercise testing in coronary patients show an improvement in both respiratory and cardiovascular parameters, after completion of a cardiovascular rehabilitation program. Our study supports current literature reports concerning this matter [22,23].

Our study opens future research perspectives. We intend to enroll more patients in our study and extend the monitoring period to 12 months in order to assess the long-term benefits of cardiovascular rehabilitation.

Variables	Mean 1	Std. deviation 1	Mean 2	Std. deviation 2	Sig. (2-tailed)
VO_2 max	1078.77	261.58	1342.5	267.25	<0.001
VO_2 max% from theoretic	50.27	13.05	62.73	13.22	<0.01
Anaerobic threshold	911.47	265.34	1101.57	347.57	0.03
Maximum effort capacity	83.93	22.73	98.47	21.87	0.01
Maximum effort capacity % from theoretic	49.77	13.34	58.2	11.2	0.01
Maximum heart rate	103.57	16.39	115.7	17.75	0.04
Maximum heart rate % from theoretic	64.07	10.32	71.67	9.6	0.008

Table 1
CPET PARAMETERS AFTER 6 MONTHS OF REHABILITATION

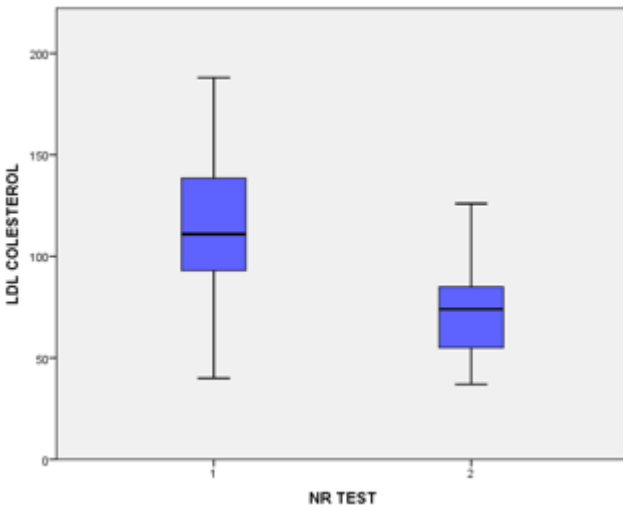

Fig. 4. LDL-cholesterol at initial and second evaluation

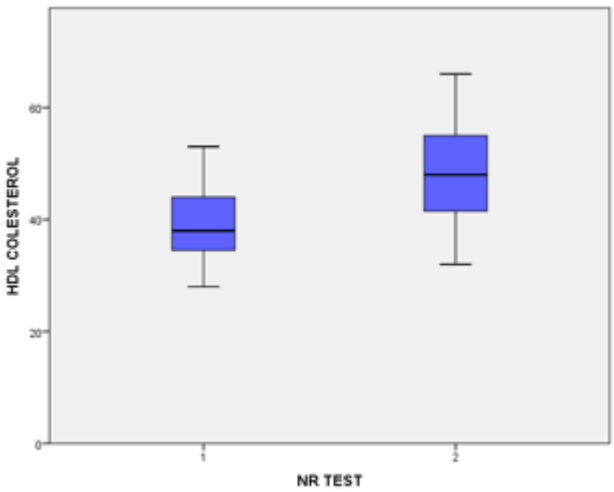

Fig. 5. HDL-cholesterol at initial and second evaluation

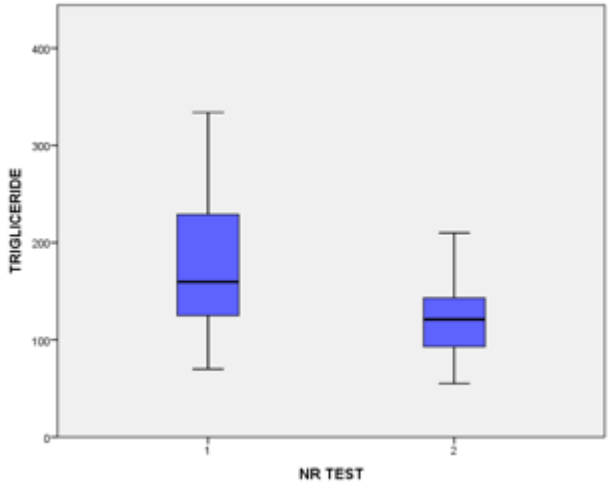

Fig. 6. Triglycerides at initial and second evaluation

Variables	Mean 1	Std. deviation 1	Mean 2	Std. deviation 2	Sig. (2-tailed)
BMI	30.8	4.55	30.3	4.32	<0.22
Total cholesterol	192.23	47.73	147.90	29.87	<0.02
LDL-Cholesterol	119.50	44.51	76.2	30.07	<0.01
HDL-Cholesterol	40.43	11.19	50.07	11.92	<0.01
Triglycerides	172.73	69.41	124.57	45.81	<0.01

Table 2
LIPID MARKERS-COMPARATIVE DATA AFTER 6 MONTHS OF REHABILITATION

Conclusions

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.

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