Factors affecting improvement in exercise capacity in patients undergoing cardiac rehabilitation program

J. Brožaitienė[1], I. Duonelienė[2], B. Vaičiūnienė[3], M. Staniūtė[4], V. Jakumaitė[5], N. Kažukauskienė[6], V. Gelžinienė[7]

[1–7]Behavioral Medicine Institute, Lithuanian University of Health Sciences, Lithuania
E-mail: *[1]jbro@ktl.mii.lt, [2]ingad@ktl.mii.lt,[3]brigitav@hotmail.com, [4]mstaniute@ktl.mii.lt, [5]vilija@ktl.mii.lt, [6]nijolekazukauskiene@yahoo.com, [7]vaidagelziniene@yahoo.com*

Abstract. Exercise capacity is known to be an important prognostic factor in patients with cardiovascular disease, particularly after myocardial infarction (MI). Impaired exercise capacity may result from several mechanisms including residual ischemia, left ventricular dysfunction, impaired peripheral adaptation, reduced heart rate variability to exercise, inflammatory and others factors. The aim of the study was to evaluate the factors affecting improvement in exercise capacity in patients after MI during early short-term exercise – based rehabilitation program.

Keywords: exercise capacity, left ventricular function, heart rate variability, cardiac rehabilitation.

Introduction

Exercise capacity is known to be an important prognostic factor in patients with cardiovascular disease, particularly after myocardial infarction (MI). Impaired exercise capacity may result from several mechanisms including residual ischemia, left ventricular dysfunction, impaired peripheral adaptation, and reduced heart rate variability to exercise, inflammatory and others factors [1–6]. The aim of the study was to evaluate the factors affecting improvement in exercise capacity in patients after MI during early short-term exercise – based rehabilitation program.

Methods and Contingent

In cross-sectional study 211 patients take part with documented acute MI (75% men and 25% women, mean age 57±9 years), admitted for cardiac rehabilitation program. They were evaluated for demographic characteristics, clinical state, for symptoms of depression/anxiety and for standard echocardiography data. Exercise capacity (EC) was evaluated using symptom-limited bicycle ergometer test, calculated as total METs achieved at peak workload (PW). All patients underwent evaluation resting and exercise heart rate variability (HRV) via the HR monitoring system on-line to PC. Standard HRV patterns were analysed: the mean R-R interval (RR, ms), standard deviation of all R-R intervals (SDNN, ms), and the very low (VLF, ms), low (LF, ms) and high frequency (HF, ms) components of HRV spectrum during rest. On the basis of the rhythmogram (RR intervals), registered during bicycle ergometry, HR variability quantitative parameters from RR Poincare plots were analysed: HR average (RR), maximal and minimal HR (RRmax, RRmin), maximal HR response (DRRr) or reflex control level, maximal HR variability (DRRt) reflects tonic control level, total HR variability (σRR), the part of variability related to the respiration (V) – correlated with parasympathetic impact, and general HR variability (S) measured as the square of the plot – involving both tonic and reflex control components. EC and HRV data were evaluated twice – before and after rehabilitation program.

Results

After early rehabilitation program EC significantly increased from 3.6 ±1.0 till 4.0±1.1 METs ($p<.001$). Improvement in EC definite in 145 (69%), decrease in 24 (11%), and EC remain

unchanged – in 42 (20%) patients after MI. Growing in EC was about 30% (12.3±19.9%). Dynamic data of resting HRV (the time and frequency domain data) showed that variables after short-term exercise – based rehabilitation program did not changed reliably. Data of HR Poincare plots registered during repeatable exercise test had showed significant increase ($p<.05$) in total HR variability ($\sigma RR = 116.1 \pm 42.5$ vs. 125.5 ± 42.8 ms), lessen of the minimal HR value ($RRmin = 629.8 \pm 98.9$ vs. 607.6 ± 95.8 ms), as well as increase in maximal HR response ($DRRr = 454.2 \pm 145.6$ vs. 488.7 ± 145.8 ms), demonstrating improvement of chronotropic function as well as recovery of autonomic reflex control level. Left ventricular ejection fraction in the group was 47.7±7.8%. Three models of multivariate linear regression analysis (enter method) was performed to identify the independent predictors of basal EC, EC after rehabilitation and improvement in EC (stepwise) after adjusting for age, gender, heart failure, angina pectoris class, diabetes mellitus, anxiety/depression symptoms, echocardiography data and HR variability values at rest and during exercise test. Determinants of baseline EC (model $R2 = 0.68$) were gender ($\beta = –0.30$, $p = .001$), heart failure stages ($\beta = –0.35$, $p = .0001$), data of echocardiography ($\beta = –0.33$, $p = .007$) and maximal HR during PW ($\beta = –0.24$, $p = .006$). Determinants of EC after rehabilitation (model $R2 = 0.67$) remained gender, initial data of echocardiography, reducing of depression symptoms ($\beta = –0.18$, $p = .029$), exercisežrelated heart rate variability ($\beta = 0.65$, $p = .025$) and maximal HR during PW ($\beta = –0.24$, $p = .003$). The improvement in EC (model $R2 = 0.43$) was determined by baseline EC ($\beta = –0.69$, $p<.001$), heart failure stages ($\beta = –0.26$, $p = .019$), exercise-related HRV ($\beta = 0.85$, $p = .025$) and maximal HR during PW ($\beta = –0.25$, $p = .032$).

Conclusion

After short-term exercise-based rehabilitation program exercise capacity in patients after myocardial infarction is strongly related with gender, data of echocardiography, reduction symptoms of depression, exercise-related heart rate variability, and maximal heart rate achieved during peak workload. Improvement in exercise capacity is related with basal exercise capacity, heart failure stages, exercise-related heart rate variability and maximal heart rate during peak workload.

References

[1] **Monmeneu J.V., Chorro F.J., Bodi V., Sanchis J., Llacer A., Garsia-Civera R., Ruisz R., Sanjuan R., Burguera M., Lopez-Merino V.** Relationships between heart rate variability, functional capacity, and left ventricular function following myocardial infarction: an evaluation after one week and six months. Clin. Cardiol., 24, 2001, p. 313–320.

[2] **Iellamo F.** Neural mechanisms of cardiovascular regulation during exercise. Autonomic Neuroscience: Basic and Clinical, 90, 2001, p. 66–75.

[3] **Oya M., Itoh H., Kato K., Tanabe K., Murayama M.** Effects of exercise training on the recovery of the autonomic nervous system and exercise capacity after acute myocardial infarction. Jpn Circ J, 63, 1999, p. 843–848.

[4] **Specchia G., De Servi S., Scire A., Assandri J., Berzuini C., Angoli L.** *et al***.** Interaction between exercise training and ejection in predicting prognosis after a first myocardial infarction. Circulation, 94, 1996, p. 978–982.

[5] **Freitas P.D., Haida A., Bousquet M., Richard L., Mauriege P., Guiraud T.** Short-term impact of a 4-week intensive rehabilitation program on quality of life and anxiety-depression. Ann Phys Rehabil, 229, 2011, p. 1–12.

[6] **Egger E., Schmid J.P., Schmid R.W., Saner H., von Kanel R.** Depression and anxiety symptoms affect change in exercise capacity during cardiac rehabilitation. Eur J Cardiovasc Prev rehabil, Vol. 15, Issue 6, 2008, p. 704–8.