Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.elsevier.com/locate/medici

Original Research Article

Cardiovascular changes during the performance by nonathletes of Bosco repeated jumps anaerobic test

Jonas Poderys *, *Albinas Grūnovas*, *Kristina Poderienė*, *Alfonsas Buliuolis*, *Viktoras Šilinskas*, *Eugenijus Trinkūnas*

Lithuanian Sports University, Kaunas, Lithuania

ARTICLE INFO

Article history:
Received 3 June 2014
Accepted 9 June 2015
Available online 2 July 2015

Keywords:
Bosco test
Cardiovascular system
Recovery

ABSTRACT

Objective: The aim of this study was to find out the characteristics of cardiovascular changes when performing Bosco repeated jumps anaerobic test depending on the duration of jumping in a nonathletes cohort.

Materials and methods: Changes in arterial blood pressure indices and changes in 12-lead ECG indices were analyzed. The characteristics of recovery after workloads were assessed by evaluating the time of half period of recovery of registered indices and by the Lyapunov exponent.

Results: The results have shown that the ratio of JT and RR intervals of ECG (JT/RR) can be useful for outlining to what extent a cardiovascular function was mobilized. The mobilization of cardiovascular function when performing a 30-s jump test changed up to 0.454 $\pm$ 0.012 and when performing a Bosco test, up to the maximal values, i.e. 0.634 $\pm$ 0.004. When performing jumps of maximal intensity, a maximal change of JT/RR occurrence was between 50 and 60 s. The increasingly serious myocardial ischemic episodes were observed at the onset of the jumping task. The duration of 60-s of all-out jump test has made an influence on the stability of the recovery processes of cardiovascular indices, i.e. the nonexponential type of recovery was observed.

Conclusions: When performing Bosco 60-s repeated jumps in an anaerobic test, a maximal mobilization of the cardiovascular system occurs between 50 and 60 s. The 30-s all-out test duration in jumping is enough to outline at what extent cardiovascular function was mobilized as well as to assess other functional characteristics during high intensity intensive exercising.

* *Corresponding author at*: Lithuanian Sports University, Sporto 6, 44221 Kaunas, Lithuania.
E-mail address: liudas.poderys@lsu.lt (J. Poderys).

Peer review under the responsibility of the Lithuanian University of Health Sciences.

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.medici.2015.06.003

1. Introduction

At the onset of exercise the cardiovascular system adapts itself with a series of integrated responses to meet the metabolic demands of exercising muscles [1]. Since the cardiovascular system is one of the constituent parts of the holistic system of the body, the reactions of the cardiovascular system to constant-load tests or all-out tests allow assessing the functional capabilities and functional characteristics of the body [2–4]. Anaerobic tests are designed to measure anaerobic power and anaerobic capacity [5]. The development of simple, noninvasive tests of work capacities, underpinned primarily by anaerobic metabolism, proliferated in the early 1970s. A 30-s maximal cycle test developed at the Wingate Institute initiated efforts to develop work tests of anaerobic capacities. Various tests, such as force–velocity tests, vertical jump tests, staircase tests, and cycle ergometer tests are used. The first studies concluded that the values of maximal anaerobic power and anaerobic capacity obtained with these different protocols are different but generally well correlated [6]. However, the last studies have shown that each test, for example the Bosco and Wingate tests, both of which measure anaerobic characteristics, appear to measure different aspects of anaerobic power and capacity. The Bosco test was applied to evaluate human anaerobic power and capacity [7]. The Bosco test also may be inappropriate for individuals who are not well trained in jumping [7]. The objective of this study was to find out the characteristics of cardiovascular changes when performing the Bosco repeated jumps anaerobic test depending on the duration of jumping in a nonathletes cohort.

2. Materials and methods

The subjects of this study were 11 volunteer male students who were not engaged in sports training with a mean age of 20.9 years (SEM, 1.21) and body mass index of 22.3 kg/m^2 (SEM, 0.38). Three tests were performed: a Roufier test (30 squats per 45 s), a 60-s Bosco repeated jumps anaerobic test, and a 30-s all-out repeated jumps test. The jumps were conducted on a force platform. In order to prevent venous pooling the subjects underwent 10 s squats after finishing the jumps and sat still during the next 3 min of the recovery. Indirect arterial blood pressure (ABP) measurements were taken from the arm with a sphygmomanometer and standard-size arm cuff before exercise test and after exercise during the first 3 min of recovery. A computerized ECG analysis system ''Kaunas-load'' was applied for 12-lead ECG recording and analysis. The changes in RR interval or heart rate (HR), JT interval, ST-segment depression (sum of negative values in 12 leads) and in the ratio of intervals JT/RR were analyzed. The program also allowed evaluation the changes of JT interval – $(JT_i/JT_0)100\%$ in comparison with the changes of RR interval – $(RR_i/RR_0)100\%$ as a difference,

$$V_{Ad} = \left(\frac{JT_i}{JT_0}\right)100\% - \left(\frac{RR_i}{RR_0}\right)100\%,$$

where V_{Ad} indicates index velocity of adaptation; JT_0 and RR_0, values of intervals before exercising; JT_i and RR_i, values of intervals at onset of exercising, i.e., averaged measurement during the first 10 s.

This difference was accepted as the index of the velocity of adaptation of the cardiovascular system in response to load.

The characteristics of recovery after workloads were assessed by evaluating the time of half period of recovery ($_{1/2}T$) of registered indices and second, by the Lyapunov exponent (LE):

$$LE = \frac{1}{N}\sum_{i=1}^{N}\ln\left(\frac{X_{i+1}}{X_i}\right),$$

where X indicates discrete signal values of moments in time; $N \in \mathbf{N}$ (set of natural numbers).

The obtained value of LE was accepted as an indicator of stability in the whole process of recovery [8].

The relationships between parameters were assessed using Spearman correlation. The significance of the difference between values was evaluated by computing t criterion, i.e., the paired t test was used. The difference was considered statistically significant when P was <0.05.

3. Results

At the onset of repeated jump test abrupt changes of cardiovascular indices occurred. Figure presents the dynamics of registered ECG indices when performing a Bosco 60 s repeated jump test and during the recovery. Some of the indices, such as heart rate, JT interval and JT/RR ratio, increased rapidly and at the end of exercise test they increased up to the maximum values. The values of changes depended on the duration of the workload but no significant differences in the dynamics of cardiovascular indices during the first 30 s of jumping were found. If the maximal values registered at the end of both jumps tests were compared, it becomes obvious that the greatest changes during the performance of 60-s Bosco repeated jumps test were obtained. The statistically significant differences were between the changes in heart rate, JT interval, ST-segment depression, ratio of JT/RR and systolic ABP ($P < 0.05$). The dynamics of ABP after the performance of 30-s and 60-s all-out repeated jumps anaerobic tests is presented in Table 1. The comparison of these two exercise tests did not reveal any essential differences except for the fact that bigger changes in systolic ABP ($P < 0.05$) and slower recovery in the performance of 60-s all-out repeated jumps were observed ($P < 0.05$).

The velocity of adaptation at the onset of exercise tests was assessed making use of the index of velocity of adaptation (V_{Ad}). The data obtained during the study are presented in Table 2. No statistically significant difference in V_{Ad} obtained during various exercise tests ($P < 0.05$) was found.

The results obtained during this study showed that the ratio JT/RR can be useful for outlining to what extent a cardiovascular function was mobilized. The mobilization of cardiovascular function when performing a Roufier test changed up to 0.427 ± 0.008, when performing a 30-s jump test–up to 0.454 ± 0.012 and when performing a Bosco test as it was shown in Figure up to the maximal values, i.e. 0.634 ± 0.004. We must point out that when performing jumps of maximal intensity, maximal changes of JT/RR occurrence was between 50 and 60 s.