



DROP JUMP AND MUSCLE DAMAGE MARKERS

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Abstract Plyometric exercises use rapid, powerful movements preceded by a preloading countermovement that activates the Stretch-Shortening Cycle (SSC). The Drop Jump (DJ) is a very common SSC exercise used in sport training which is eccentric-biased. Eccentric actions are associated with skeletal muscle tissue damage, and serum muscle enzyme activity like CK and LDH are used as muscle damage markers. The aim of this study was to measure the magnitude of muscle damage markers after a DJ session. Sixteen men (18±3 years old; 177± 4 cm height; and 71±4 kg weight) were submitted to 4 sets of 10 Drop Jumps from 30 cm with 1 min interval between the series. All had blood collected before and after the exercise (24, 48 and 72h) to assay the serum activity of CK and LDH. One-way analysis of variance (ANOVA) was used to test the differences in serum enzyme activity and the alpha level was set at 0.05. The serum CK activity increased significantly in all samples, reaching the peak at 72 h after exercise (~ 277%; p<0.01). A similar result was reached with the activity of serum LDH (~ 100% increase at 72h; p<0.05). None of the results exceeded the reference values proposed for athletes. We have concluded that the DJ causes changes in muscle metabolism indicators increasing serum CK and LDH activity.

Key words: Creatine kinase, lactate dehydrogenase, plyometrics, exercise

INTRODUCTION

Plyometric exercises have been demonstrated to improve power output, agility, and running economy. These exercises use rapid, powerful movements that are preceded by a preloading countermovement that activates the stretch-shortening cycle (SSC). The SSC involves the mechanical stretching of muscles and tendons immediately prior to rapid concentric contractions. Mechanisms proposed to contribute to the SSC include the neural potentiation of the contractile machinery during the eccentric phase and reflex contributions from the muscle spindle [11]. One of the most commonly used plyometric exercises is the Drop Jump (DJ). The DJ requires the athlete to step from a measured drop height and, on landing on the ground, to perform a maximal effort vertical jump, with a short ground-contact period [14].

The DJ is an eccentric-biased exercise, and the eccentric actions are associated with skeletal muscle tissue damage with sarcolemma disruption and sarcomeric degeneration from Z-disk fragmentation. This fact augments the serum level of skeletal muscle enzymes. Creatine kinase (CK), lactate dehydrogenase (LDH) and myoglobin have been extensively used as markers for muscle micro-damages [2, 3, 8, 10, 12, 13]. Under such conditions CK serum concentration displays a greater increase than the serum concentration of other muscle proteins. As a result, CK is used widely as such a marker of the status of muscle tissue [1, 3, 7, 8].

Plyometric exercises has been investigated in a great number of studies [4, 5, 6, 9, 11] along with the effect of eccentric exercise on muscle damage markers [2, 8, 10], but research on the effect of SSC on muscle markers serum activity is rare. The aim of this study was to measure the magnitude of variations of CK and LDH serum activity after one bout of a Drop Jump session.

MATERIALS AND METHODS

SAMPLES

The study group included 16 moderately active males (18 ± 3 years old; 177 ± 4 cm height; and 71 ± 4 kg weight), healthy, non-smokers, who used no drugs, dietary supplements, or anabolic steroids. The experimental conditions were in accordance with the norms of the BRAZILIAN NATIONAL HEALTH COUNCIL, under RESOLUTION No. 196, promulgated on 10 October 1996, referring to scientific research on human subjects, and Helsinki Declaration (1964, reformulated in 1975, 1983, 1989 and 1996) of the World Medical Association (http://www.wma.net/e/policy/17-c_e.html). The subjects participated voluntarily.

EXPERIMENTAL PROTOCOL

On the first day all subjects were submitted to an anthropometrical measurement (height and weight) and blood samples were collected. After a warm up (stretching and jogging) each subject executed four sets with 10 maximal Drop Jumps (from the platform 33 cm high). Between sets a passive rest of 60 seconds was administered. Other blood samples were collected 24, 48 and 72 hours after the first collection.

DATA COLLECTION

Venous blood samples were collected from the forearm while the subjects were in a seated position. The first sample (PRE, 0) was collected in the morning and other samples 24, 48, and 72h later. The blood samples were centrifuged; the separated serum was quickly frozen and stored at -8°C . Creatine kinase (CK) and lactate dehydrogenase (LDH) activity were measured from the serum samples. An enzymatic method was used for enzyme activity analysis with commercial kits (BioTécnica - Brazil) in a Cobas Mira Plus analyzer (Roche - Germany).

STATISTICAL ANALYSIS

One-way analysis of variance (ANOVA) was used to test the differences in serum enzyme activity between different times of sampling. The alpha level was set at 0.05 in order for the difference to be considered significant. When a significant effect was detected, a pair wise comparison of the sessions was carried out using Tukey's post hoc test to identify significant differences between times. Statistical treatment was done using SPSS® 13.0 for Windows (LEAD Technologies, 2004).

RESULTS

The serum CK and LDH activity was significantly higher ($p < 0.01$) across the days as shown in Figure 1 and 2. The peak in CK values was manifested 48-72h post-exercise; these data are in agreement with the previous studies investigating the relationship between exercise and serum enzyme activity response [2, 7, 8, 10].

DISCUSSION

As presented in the introduction, the serum enzyme activity serves as an index of both over-exertion and adaptation of the muscular system in exercise. Total CK levels depend on age, gender, muscle mass and physical activity. High levels of serum CK in apparently healthy subjects can be correlated with physical training status, as they depend on sarcomeric damage: strenuous exercise that damages skeletal muscle cells results in increased total serum CK. Total serum CK activity is markedly elevated at 48 h after the exercise bout and it gradually returns to basal levels (~ 96 h later) when the subject rests. Some studies [1, 7] demonstrated that the serum CK activity raised 24h after the session training and this effect was prolonged for 48 and 72 h after the training session. The present study corroborates previous reports: the CK concentration rose in 24, 48 and 72h after the training session.

Repeated stretching of the quadriceps during the DJ might have led to disruption in muscle fibers as a result of early fatigue and temporary increases in muscle stiffness caused within these fibers by the eccentric component [14]. Many studies [2, 3, 8, 12] have shown that eccentric actions are the most capable of causing damage and increasing the activity of serum enzymes. As the DJ is a vigorous eccentric exercise, high values for the activity of serum CK and LDH were expected, especially due to the rapid eccentric muscle actions induced by the stretch reflex, which accentuates muscle effort and muscle damage.

In this study the activity levels achieved increases of $\sim 277\%$ and $\sim 100\%$ in CK and LDH, respectively; these data are consistent with other studies, even those using different methodologies. Mougios [7] proposed reference values for athletes of various sports, without specifying the type of training that each used (Table 1). Our data showed values within the range proposed by the study of Mougios [7].

Thus we can speculate that the dosage of enzymes may be used as a control and security of plyometric training.

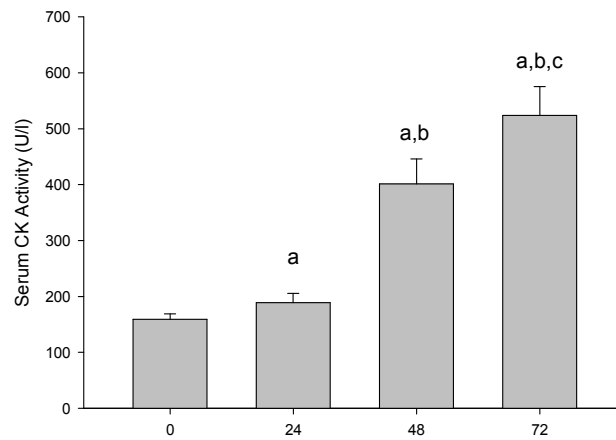


Figure 1. Mean \pm SE (standard error) of serum CK activity. (a) Significantly higher when compared to 0h ($p < 0.01$); (b) Significantly higher when compared to 24h ($p < 0.01$); (c) Significantly higher when compared to 48h ($p < 0.01$).

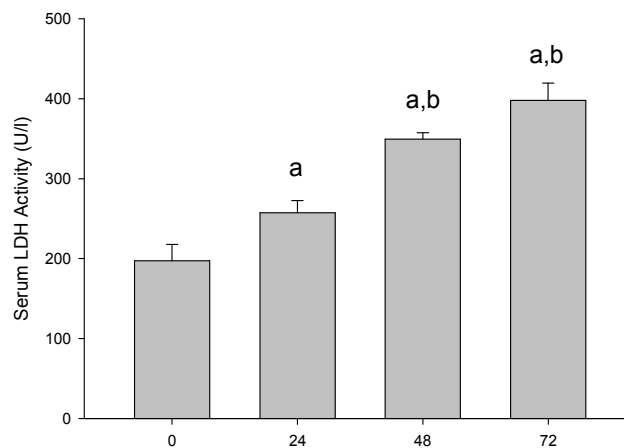


Figure 2. Mean \pm SE (standard error) of serum LDH activity. (a) Significantly higher when compared to 0h ($p < 0.05$); (b) Significantly higher when compared to 24h ($p < 0.05$); (c) Significantly higher when compared to 48h ($p < 0.05$).

Table 1. Serum CK activity (U/L) reference intervals in accordance with Mougios, 2007 [7].

| Group | Lower reference limit (90% CI) | Upper reference limit (90% CI) |
|---------------------|--------------------------------|--------------------------------|
| Male Athletes | 82 (73-86) | 1083 (881-1479) |
| Female Athletes | 47 (39-55) | 513 (404-863) |
| Male Non-Athletes | 45 (39-72) | 491 (369-728) |
| Female Non-Athletes | 25 (17-30) | 252 (14-345) |

Our study corroborates the findings of Twist & Eston [14], in respect of the DJ causing exercise induced micro-lesions. Peak power output, time to peak power output, drop jump height, ground contact time during the drop jump, and strength at both joint angular velocities were all adversely affected in the study by Twist & Eston [14]. All these factors are indicators of fatigue and / or micro-damage induced by exercise. The authors did not measure the blood parameters of micro-lesions, but our results reinforce the results of these.

CONCLUSIONS

The data from this study show that the DJ causes increased activity of serum CK and LDH and that despite the strong influence of the eccentric action, the DJ used as in this study does not cause major changes in comparison to other types of training.

PRACTICAL APPLICATION

The data from the current study can be applied to athletes undergoing plyometric training. Clinicians, researchers, strength and conditioning professionals and athletes should realise that few studies have the statistical power to detect severe adverse events. Our results cannot be generalized to athletes who perform other plyometric exercises combining them with other training types. Our data suggest that the use of the DJ can be safe.

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