

Full Length Research Paper

Effects of short-term exercise on heart-rate blood pressure oxidative stress paraoxonase activity and lipid hydroperoxide

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This study inquired the effects of short-term exercise on heart-beats, blood pressure, total anti-oxidative capacity (TAC), total oxidative stress (TOS), lipid hydro-peroxide (LOOHs) and Paraoxonase (PON) in football players. 22 male football players, who perform exercise regularly at least three times a week and two hours a day, participated in this study on voluntary basis. Heart-beats, systolic and diastolic blood pressures and blood samples were taken from the football players before and right after the short-term exercise. Their Total Antioxidant Capacity (TAC), Total Oxidative Stress (TOS), Lipid Hydro-peroxide (LOOHs) and Paraoxonase (PON) levels were measured and assessed. It was found that football players displayed significant increase in heart-beats ($p < 0.01$) and systolic blood pressure ($p < 0.05$), significant decrease in TAC values ($p < 0.05$), and significant increase in the oxidative status (TOS) value ($p < 0.05$) after the short-term exercise compared to the pre-exercise levels. No significant change was observed in diastolic blood pressure, lipid hydro-peroxide (LOOHs) and Paraoxonase (PON) levels. In this study, it was found that the balance shifted towards oxidative stress due to decreased antioxidants and increased oxidants after short-term exercise. In order to reduce such a high oxidative stress and to prevent athletes from its adverse effects, it necessary to have an antioxidant-rich diet before any exercise or to get antioxidant supplements.

Key words: Football, short-term exercise, oxidants, antioxidants.

INTRODUCTION

Exercise results in oxidant creation and oxidative stress due to its dual effect and also induces the antioxidant synthesis (Ji, 1995). It is well-known that physical exercise may result in a shift in oxidant/antioxidant balance whose importance is well-proven in both physiological and pathological processes such as intracellular signal transmission, apoptosis, anti-microbial defense, muscular damage and fatigue, ageing, the Alzheimer's disease, some types of cancer, atherosclerosis, myocardial infarcts and ischemia/reperfusion damage (Atalay and Laaksonen, 2002). Physical exercise is characterized by metabolic activity and increased oxygen consumption. Such increased oxygen consumption is accompanied by an increase in formulation of reactive oxygen types. It is recognized that such an increase in reactive oxygen types might also be responsible for many physiological and biochemical changes that take place during exercise (Alessio, 1993; McArdle and Jackson, 2000). The organism has a

complex antioxidant defense system containing the intracellular elements, the cellular membrane and extracellular liquids in order to minimize the free radicals damage (Sen, 1995; Jenkins, 1988; Powers and Lennon, 1999). Blood, which ensures transportation of antioxidants all over the body, has a central role within the strategy of sustaining the Redox balance under oxidant conditions. Total antioxidant status (TAS) is considered as an indicator of capacity of the antioxidants within biological fluids to protect the membranes and other cellular components vis-à-vis the oxidative damage (MacKinnon et al, 1999).

Previous research indicated the effect of short term exercise on blood pressure (Pescatello, 1991; Johannes et al., 1995; Christian et al., 2002; Whelton et al., 2002), oxidative stress (Cooper et al., 2002; Urso et al., 2003; Roberts et al., 2006) and Lipid Hydroperoxide (Vincent et al., 2000; Roberts et al., 2006; Hamilton et al., 2001).

This study aimed at defining the correlation between

short-term exhausting exercise and heart-beats, blood pressure and oxidant/antioxidant balance. Total oxidative status (TOS) and lipid hydro-peroxide (LOOH) levels were checked to examine the effects of short-term exhausting exercise on the oxidative stress, and Total Antioxidant Capacity (TAC) and Paraoxonase (PON) levels were checked for antioxidant parameters.

MATERIALS AND METHODS

Subjects

Twenty two non-professional male football players who perform exercise regularly 3 times a week and 2 h a day participated in this study on voluntary basis. After the subjects were informed of all the details concerning the study and the Ethic Principles Applied in Clinical Research on Human Subjects of the Helsinki Declaration of World Medical Association was read to them, they signed voluntary participation forms. The permission required for this study was taken from the Ethical Committee. Subjects were not allowed to make any exercise or take any vitamin and were given the same diet for three days prior to the study. All the subjects were warned not to eat or drink anything three hours prior to the test.

Exercise program

Circular station exercise was given to the subjects. Exercise consisted of 8 different movement and stations. Before the exercise, subjects warmed up for 15 min. Each exercise was composed of 3 sets and 5 min breaks were given between each two sets. Exercises and movements were made for 20 s and subjects rested for 30 s after each exercise. Exercises were applied in groups of eight people with a blasting tempo and continuously monitored by two experienced trainers. Total exercise duration was 30 min. Exercise stations were in the following order: Double-leg jumping, 5 m sprint, foot-pulling on the floor (one by one), standing up and jumping from prone position, reverse sit-up, running with high knees, single-leg jump, and standing up and jumping from supine position.

Measurement methods

In the study, measurements were made before and right after the implementation of the training program. Ages of the athletes were defined as years and their heights were scaled by a meter with 0.1 cm sensitivity and a metal rod attached to the meter. Weight was measured by means of a digital weighting machine with 0.01 kg sensitivity, while systolic and diastolic blood pressures were measure by means of a stethoscope and sphygmomanometer. The radial artery on the wrist was used to record the heart-beats. The pulse was recorded for one minute by putting the index finger and the middle finger on the artery. Venous blood samples were taken into tubes with EDTA and heparin for measurement of oxidant/anti-oxidant values. Total Anti-oxidant Capacity (TAC) was defined through a method that measures the total anti-oxidant capacity of the body vis-à-vis strong free radicals in accordance with the literature (Erel, 2004). LOOH was measured by using a full-automatic method developed by Khelifa Arab and Jean-Paul Steghens, which utilizes xylenol orange and Fe⁺⁺ (Arab and Steghens, 2004). Total Oxidant Level (TOS) was defined by a full-automatic calorimetric method developed by Erel (2004). PON was measured by the method of Juretic et al. (2001) in Hitachi DP Modular Systems (Roche Diagnostics) analysis.

Statistical analysis

In order to define the differences between the measurement results before and after the exercise, their arithmetical mean (X) and standard deviation (SD) were calculated; and in order to determine whether the difference between the arithmetic means within the same groups is as significant as 0.05, Paired-Samples T-test was utilized. Statistical works were conducted through SPSS 14.0 for Windows.

RESULTS

Average age of the subjects was calculated as 16.13 ± 1.42 years, average height as 152.9 ± 49.9 cm, average weight as 52.90 ± 11.5 kg, and Body Mass Index(BMI) as 19.8 ± 3.2 kg/ m² (Table 1).

In Table 2, post-exercise heart-rates ($p < 0.001$) and systolic blood pressure increased significantly ($p < 0.05$), whereas, the increase in diastolic blood pressure was not statistically significant ($p > 0.05$).

According to the results of pre and post exercise; Total Anti-oxidant Capacity (TAC) and Total Oxidative Stress (TOS) values of the subjects was found to be statistically significant at $p < 0.005$ level. The scores of pre and post-exercise showed that lipid hydro-peroxide (LOOH) and paraoxonase (PON) values were not found statistically significant (Table 3).

DISCUSSION

A comparison between pre- and post-exercise heart-beats and systolic and diastolic blood pressures shows that heart-beats and systolic blood pressures have displayed a significant increase, while the changes in diastolic blood pressure was not considered statistically significant (Table 2).

The effect of exercise on heart-beats and blood pressure stems from the increase taking place in the beating volume and heart output. Blood pressure goes down due to the reduced peripheral vascular resistance. The type of the exercise made is also important and peripheral vascular resistance increase is much more obvious in static exercises such as weight-lifting. Vascular resistance decreases due to the increased blood flow, and blood pressure exhibits an increase depending on the physical condition of the athlete and type and magnitude of the exercise. As we do analyze the increase in systolic and diastolic blood pressure during the exercise, we observed that this increase was much more obvious in systolic blood pressure, whereas, diastolic blood pressure increase had little change. The increase in the cardiac flow affects particularly the systolic blood pressure and turns it up to as high as 140 to 160 mmHg (Günay and Cicioğlu, 2001).

A significant decrease was statistically observed in TAC (Total Antioxidant Capacity) after short term exercise. The difference between pre- and post-exercise

Table 1. Subject characteristics (n = 22).

Parameter	Mean	SD
Age (Years)	16.13	1.42
Height (cm)	152.9	49.9
Body weight (kg)	52.9	11.5
BMI (kg/ m ²)	19.8	3.2

Table 2. A comparison of pre and post tests of heart-rate and blood pressures of the athletes (n = 22).

Parameter	Pre-test (mean ± SD)	Post-test (mean ± SD)	T	Sig.
Heart-Rate	71.81 ± 27.79	108.55 ± 2.57	-8.195	0.000 *
Systolic BP(mm Hg)	105.26 ± 13.06	110,42 ± 12.60	-2.237	0.038 **
Diastolic BP(mm Hg)	67.77 ± 8.94	70,00 ± 9.07	-1.017	0.323

* p < 0.001; ** p < 0.05.

Table 3. A comparison of TAC, TOS, LOOH and PON values of athletes (n = 22).

Parameter	Pre-test (mean ± SD)	Post-test (mean ± SD)	T	Sig.
TAC(mmol Trolox equiv./l)	1.03 ± 0.18	0.94 ± 0.13	2.34	0.037**
TOS(mmol H ₂ O ₂ /l)	10.88 ± 2.71	12.19 ± 3.21	-2.222	0.032**
LOOH(μmol H ₂ O ₂ Eqiv./L)	3.84 ± 0.73	4.03 ± 0.86	-1.237	0.830
PON (U/L)	154.19 ± 111.9	120.57 ± 58.82	1.669	0.119

LOOH, (Lipid hydroperoxide) and PON (Paraoxonase) levels was not found statistically significant (Table 3).

It was stated that different types of exercises resulted in oxidative stress at different levels (Sen, 1995, Alessio, 1993; Sen et al., 1994). In addition to the studies arguing that long-term regular exercise results in an improved anti-oxidant defense system (Di Massimo, 2004; Ji, 1995), it was also stated that exercises at higher intensity increased oxygen consumption by 10 to 15 folds, which also in turn increases the production of free radicals and results in an increased oxidative stress and a weakened antioxidant defense system (Fiçıcılar et al., 2003; Berlin and Colditz, 1990; Fletcher et al., 1995). However, some studies reported that exercise did not affect antioxidant level (Poulsen et al., 1996; Hartmann et al., 1994; Poulsen et al., 1999).

Some studies (Jamurtas et al., 2003) also suggested that regular strength and resistance-oriented exercises decreased oxidative stress and increased antioxidant levels. Another study (Inal et al., 2001) reported that long and short-distance swimming increased the activity of anti-oxidant enzymes. Leaf et al. (1999) reported that, although single-load maximal aerobic exercise results in oxidative stress, participation in regular physical exercise ensures that adverse effects of oxidation is turned down through adaptation to exercise and the oxidative stress stemming from the exercise.

A comparison with the literature shows that TAC displayed a significant decrease after short-term exercise in our study. The decrease in TAC values was compatible with some studies, which not so with some others. The fact that TAC values significantly decreased after the exercise, points that the organism falls short in standing effectively against the increased load of free radicals stemming from exercise. It was also determined that the TOS level of athletes in the experiment group increases significantly after the short-term exercise. The fact that athletes displayed increased TOS levels after the exercise was also compatible with some studies, which not so in some others. It was considered that the increased oxygen consumption due to short-term highly-intense exercise might be related to significantly-increased oxidative stress. Literature suggests different results in this field. There are many studies in the literature whose results are compatible or not with ours. An analysis of these studies has shown that these studies were conducted with people from different genders, age groups and sports, performing exercise of different terms and magnitude, in communities with different socio-economic levels, which makes it very difficult to compare and analyze the results of these studies conducted in different experiment groups through different methods. This may be the reason for similarities and differences between our findings and other studies.

Conclusion

We can suggest that short-term, intense exercise results in increased oxidative stress and decreased anti-oxidant capacity in non-professional football players. It may be useful to render anti-oxidant supplements to exercise-making individuals in order to reduce oxidative stress and increase the anti-oxidant capacity. Antioxidant supplements may also increase the performance of individuals under training (or practice). However, we believe that further studies are needed in this field.

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