Medicina Sportiva, Vol. 10 (4): 102-104, 2006

INFLUENCE OF MAXIMAL EXERCISE ON ORGANISM'S ANTIOXIDANT POTENTIAL IN FIELD HOCKEY PLAYERS

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Abstract

56 field hockey players from Poznan field hockey clubs were investigated. Sportsmen, running on motorised treadmill performed a maximal incremental exercise test. Physiological parameters were examined on wireless portable ergospirometry system. In blood plasma we determined lactic acid and plasma antioxidant parameters (FRAP, total polyphenols, TBARS and allantoin). The tests showed that field hockey players have a high oxygen efficiency and high tolerance to effects of free radicals.

Key words: field hockey, maximal exercise, antioxidant potential

Introduction

Field hockey belongs to the team-plays with clear attributes of aerobic and anaerobic effort. Biometric study during matches indicate that sportsman through about 85 percent of playing time perform exercises with typical aerobic characteristics. The rest of game-time prevail sprint and fast pick-ups, while in hockeys' organisms lead to advantage of anaerobic pathways (1). Physical effort, especially with mixed attributes, generate a large amount of free radicals, which are able to damage (2), proteins (3) and lipids (4). The consequences of such events are disturbances of muscle cell function and reduced efficiency generated from higher fatigue of muscles (5). Depending on conditions in which oxidative stress appeared in sportsmen's organisms, different biochemical parameters are built indicating on failure. Malondialdehyde (MDA) and its derivatives are markers of cell structure damage found during effort with typical aerobic characteristic. They are formed as products of lipids decay caused by reactive oxygen species (ROS) effect (6). Estimation of allantoin concentration, a substance made from modified purine generated during free radicals reaction, is more specific marker during anaerobic exercise (7).

The goal of this study was the assessment of plasma oxidant-antioxidant (redox) potential in field hockey players group during maximal exercise test realized on treadmill.

Material and methods

56 field hockey players from four leading Poznan field hockey clubs, were tested during the preparatory phase. Body mass and height of sportsmen were specified directly before test performance (Tab. 1). All hockey players involved in this study declared fine state of health and did not take any analgesic and anti-inflammatory medicine at least five days before tests beginning. The experimental protocol was approved by the Ethics Commission at Poznan University of Medical Sciences.

Table 1. *Physical characteristics of the subjects (n=56)*

Variable	Mean ± SD
Age [years]	23.2 ± 5.7
Body weight [kg]	74.2 ± 9.3
Body height [cm]	177.9 ± 5.6
BMI [kg · m^{-2}]	23.4 ± 2.1
Training experience [years]	13.7 ± 5.5

BMI- Body Mass Index, SD- Standard Deviation

Sportsmen, running on motorised treadmill (Marathon, Kettler, Germany), were put to the maximal incremental exercise. Respiratory parameters were determined using a wireless portable ergospirometry system (Oxycon Mobile, Jaeger, Germany). Circulatory parameters (HR_{ppa}, HR_{max}) were continuously monitored with a Sport Tester device (Polar, Finland). Physical efficiency of hockey players was determined with Ppa (ventilation method) and $\dot{V}O_2max$. Furthermore two parameters: time and covered distance were measured as effort tolerance index.

Blood for investigation was collected three times (T_1, T_2, T_3) using disposable needles and syringes.

Fasting blood (10 ml) for potential redox determination was taken from the antecubital vein between 8.00-8.30 to the tubes with K_2EDTA as an anticoagulant (T_1). Moreover, capillary blood from pulp of the finger was collected to a glass capillary to estimate the resting lactic acid (LA) (T_1). Three minutes after the effort-test on treadmill, capillary blood was collected for after-exercise concentration of LA determination (T_2). Third time the vein blood was collected 10 minutes after the test was finished (T_3). Blood samples were immediately centrifuged (4000rpm, 20 min, 4°C), and the extracted plasma was stored at -80°C.

Lactic acid concentration was determined using enzymatic method from capillary blood supernatant, and was expressed as mmol·L^{-1} of full blood. Absorbance changes were detected with spectrophotometer (Marcel Media plus, Marcel Sp. zo.o., Poland), using wavelength (λ) of 340 nm. Plasma total antioxidant status was determined using FRAP method (Ferric Reducing Ability of Plasma) developed by Benzie (8) and modified by Janaszewska and Bartosz (9). Absorbance of received solution was measured using ELISA Microplate Reader (EL808; BioTech, USA), λ=600 nm and concentration was expressed at µmol·L^{-1} of plasma. The Concentration of total phenols substances (total polyphenols) in plasma was measured with method published by Singleton (10) and detected on spectrophotometer at λ=765 nm. Total polyphenols concentration expressed as an equivalent of gallic acid in g·L^{-1} of plasma. In TBARS (Thiobarbituric Acid Reactive Substances) determination applied method developed by Ohkawa (11), and absorbance was read on ELISA Microplate Reader at λ=540 nm. The concentration of allantoin was measured in plasma on High Performance Liquid Chromatography (HPLC) with UV lamp (HP 1050, Hewlett-Packard, USA).

The two experimental trials (pre-exercise and post exercise values) were analyzed using a paired t-test associated with t-Student test. A significance level of $p<0.05$ was chosen a priori.

Results

Mean values of determined physiological parameters of field hockey players are showed in Tab. 2. Maximal values of oxygen intake ($\dot{V}O_2$max) obtained by sportsmen, traversed a distance on treadmill and maximal heart rate allow to describe their efficiency as high and proper do their age and sex.

Significant increasing of lactic acid concentration in blood plasma (***$p<0.001$) found after finishing the test on motorised treadmill point out on typical anaerobic processes in of sportsmen`s organisms.

Plasma total antioxidant status (FRAP) and total polyphenols concentration were significant increased (**$p<0.01$) ten minutes after test finishing. Concentration of TBARS, in contrast to allantoin (***$p<0.001$), was not significant changed after carry out the run. Finding values of biochemical parameters were located in Tab. 3.

Table 2. *Results achieved on treadmill and physiological parameters (n=56)*

Variable	Mean ± SD
Traverse a distance [m]	2679.8 ± 450.6
Time [min]	13.7 ± 1.7
$\dot{V}O_2$max [ml·min^{-1}·kg^{-1}]	53.6 ± 4.1
HR_{max}[beat · min^{-1}]	192.4 ± 7.3

HR_{max}- Maximal Heart Rate, SD - Standard Deviation,
$\dot{V}O_2$max - Maximum Oxygen Uptake

Table 3. *Pre- and post-exercise values of biochemical parameters (n=56)*

Parameter	Pre-exercise concentration	Post-exercise concentration	Tendency	t-test
	[Mean ± SD]			(p)
Lactic acid [mmol · L^{-1}]	T_1: 1.0 ± 0.2	T_2: 8.2 ± 2.2	↑	<0.001
FRAP [µmol · L^{-1}]	T_1: 923 ± 185	T_3: 1000 ± 172	↑	<0.01
Total polyphenols (g · L^{-1})	T_1: 2.94 ± 0.07	T_3: 3.07 ± 0.07	↑	<0.01
TBARS (µmol · L^{-1})	T_1: 4.97 ± 0.50	T_3: 4.82 ± 0.53	↓	>0.05
Allantoin (µmol · L^{-1})	T_1: 8.53 ± 5.56	T_3: 14.87 ± 6.66	↑	<0.001

↑ - increasing, ↓ - not significant decreasing
T_1- baseline time, T_2- 3 minutes after exercise, T_3- 10 minutes after exercise
FRAP- plasma total antioxidant capacity, SD- Standard Deviation,
TBARS- Thiobarbituric Acid Reactive Substances

Discussion

The Definition of relationships between experimentally applied physical effort with increasing intensity and indexes of antioxidant potential as well as concentration of total polyphenols possessed antioxidant properties were the aim of our investigation. Another aspect of this study was to define the influence of maximal effort on induction free radicals throughout determination of substances presented in blood (TBARS, allantoin), which are formed only in response of cell structure damage. Based on received results we suggest that field hockey players characterized high aerobic efficiency and anaerobic. On the proper preparation of field hockey players to keep the requirement dynamics and physical efficiency at match-time indicate both high values of $\dot{V}O_2$max and simultaneously relatively high level of lactic acid.

Received results of total antioxidant capacity and total polyphenols concentration could suggest that sportsmen's organisms respond to intensive effort by release to blood substances that protect cell structures against damaging effects of free radicals. Similar results obtained authors which carried out the studies on marathon (12) and half-marathon (13) groups. Increasing concentration of antioxidants found in blood plasma after exercise is usually accept as a protection mechanism against higher induction of free radicals. Interestingly, there are some publications where the authors showed no changes (14) during 30-minute exercise on a bicycle ergometer ($\dot{V}O_2max$=70%) and others even decreasing of antioxidant potential after triathlon race (15).

No changes of TBARS, which contains of MDA, 4-hydroksynonenal (4-HNE) and heksanal, was found in examined group of field hockey players. It may be supposed that 10 minutes after finish of exercise did not come to induction of reactive oxidative species, which could damage lipids, especially very sensitive to oxidation low density lipoproteins (LDL), which is the main source releasing MDA and derivatives. Studies carried out on half-marathon participants also showed that effort have no influence on TBARS concentration changes (15), although there are presented different trends, namely decreasing (12) or increasing concentration of this parameter (17).

The increasing amount of allantoin in blood plasma found in our study after the test on treadmill can suggest that organism defense system that prevents formation of free radicals after anaerobic exercise is less efficient in examined hockey players. Hellsten (18) presented analyses, which showed, that 2-time increase of allantoin concentration depends on intensity effort used during the test.

Conclusions

1. Post-exercise increase of the concentration of prevented antioxidant parameters should be considered as organism response on free radicals formation.
2. Constant level of TBARS in the blood plasma after physical exercise and simultaneously increasing of allantoin concentration, indicates that sportsmen are better prepared to efforts with anaerobic characteristics.

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Received: November 29, 2006
Accepted: December 27, 2006
Published: December 30, 2006

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Author's contribution
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection