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ACUTE EXERCISE-INDUCED MUSCULAR DAMAGE AFTER ONE MONTH TRAINING IN SOCCER PLAYERS

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Abstract
Purpose. The purpose of this study was to examine the effects of high intensity aerobic interval training on muscle damage markers after exhaustive maximal exercise.
Methods. Twelve soccer players performed soccer special training for 4 weeks. Before that they participated in one session exhaustive exercise in pre and post soccer special training. Blood collection was conducted in rest and exhaustion time for CPK and LDH serum level measurement.
Results. Our results showed all indicators of muscle damage changed significantly after both bouts. Based on that, significant differences between rest times and exhaustion times were evident for CPK and LDH serum level after both exhaustive exercises. Compared to the first bout, CPK and LDH levels resulted in significantly smaller changes after the second exercise bout in post high intensity aerobic intervaltraining.
Conclusion. The decline in CPK level from pre and post exhaustive exercise (rest and exhaustion time) value between bout 1 and 2 were 31% and 30%, respectively. These values for LDH level were 12% and 23%, respectively. These results suggest that 4 weeks of high intensity aerobic interval training caused significant decrease in muscle damage markers in rest and exhaustion time in soccer players.
Keywords: Muscle Damage, CPK, LDH, Hoff training, soccer players.

Introduction

During a soccer match, among various factors, physiological, technical, and tactical skills are important for optimal performance (Hoff et al., 2002). Given the soccer characteristic, during a soccer match (90 min) this game has been classified as an high intensity and intermittent sport (Mosey, 2009)and many players ordinarily run a distance between 10-12 kilometers in an intensity near to anaerobic threshold (80-90 % of maximum heart rate or 70-80 % of maximal oxygen consumption (VO_{2max}))(Mcmillan et al., 2005).

When the activity is performed in high intensity and for long time, oxygen deficiency could cause organic abnormalities or ischemia. It has proved that intense exercise will increase free radicals and simultaneously reduce antioxidant activities, by which inflammation and muscular damage will occur.

In addition intense exercises such as exhaustive exercises cause oxidative stress by which muscular damages and progressive increase in free radicals. It is reported that there is a direct relationship between rate of muscular damage and high intensity exercises, that is, the higher activity, the higher muscular damages. It has been proved that creatine phosphokinase (CPK) and lactate dehydrogenase (LDH) serum level are related to muscular and cartilage damage and inflammation (Han, Kim, 2011).

CPK in plasma could be known as none- natural stress syndrome in muscles. Untrained athletes immediately after high intensity activities, have higher blood CPK level than trained athletes. It has been reported that as CPK and LNH are as indirect indicators of muscular damages, they could be used to determine rate of effect in a training plan (Han, Kim, 2011).

Accordingly, one session of exhaustive exercise after a training period, is a very suitable sample to measure effect of oxidative stress on the body. As declared, intra muscular LDH or CPK in the blood circulation shows the fiber damage, which is created via oxygen deficiency, or mechanical damage. It is proved that trained athletes showed less increase in the serum levels of these enzymes after strenuous activity (Bhagat et al., 2006).

Therefore, the objective of this study was to investigate the effect of high intensity aerobic interval training on changes in indices of muscle damage in soccer players.

Materials and methods

Subjects

Twelve male soccer players from third Iranian divisions participated in this study after being informed about the aims, experimental protocol, procedures and after delivering writing consents. At the time of the experiments, the players were in the preparation period of the season, performing 3-4 training sessions per week. Their mean (±SD) age, height, weight and percent body fat were 21.88±2.24 yrs, 174.22±5.33 cm, 67.77±5.7 kg, and 12.38±3.29 percent, respectively.

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Experimental procedures

All subjects were recommended to get enough sleep the day before the measurement, and the objective and plan of the study were also fully presented. In addition, general adaptation training for the test equipment was implemented, and the O2 intake method was also introduced. The subject's VO_{2max} was assessed during a graded exercise treadmill (HP Cosmos Mercury Med 4.0) test using standard Bruce protocol (Bruce et al.,1973) in the morning hours. The test was terminated when subjects stated they could no longer continue with the maximum workload. At the terminal workload, all subjects had to meet at least two of the following criteria for a valid test: 1- a final respiratory exchange ratio (RER) > 1.0, 2- O2 consumption increased by < 2 $ml \cdot kg^{-1}$ with an increase in exercise intensity, 3- attainment of >85% of age-predicted maximal heart rate (Vatansever-Ozen et al, 2011).

Blood collection (10 cc) was conducted from the ante brachial vein under stable conditions using a syringe. Further, blood collection was carried out four times: before and after exhaustive exercise in pre and post high intensity aerobic intermittent training. The collected blood was stored in blood plasma tubes treated with the anti-coagulant EDTA and centrifuged at 2500 rpm for 15 minutes. Tubes were stored at -80℃ until measurement. On the following days, players performed high intensity aerobic interval training sessions (figure1).

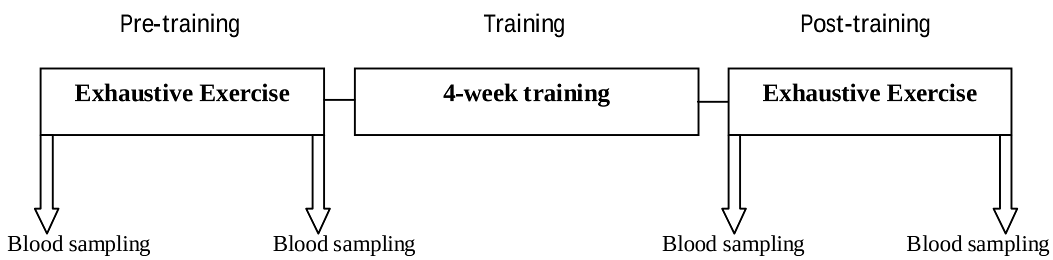

Figure1. Experimental design.

Training Intervention (Hoff training)
The aerobic training intervention consisted of interval training, comprising four bouts of 4 min work periods dribbling a soccer ball around a specially designed track (Hoff et al., 2002) (figure 2) on soccer field. Training cones used in the dribbling circuit were 0.3 m high and 0.15 m wide. Hurdle height was set at 0.5 m.
Working intensity was at 90–95% of each player's maximum heart beat, with work periods separated by 3 min of jogging at 70% of HR max.
All players wore a Polar Team System heart rate belt and monitor (Polar Electro) throughout the interval training. The interval training was performed three times a week at the end of the soccer training session, on the same days and time of day throughout the intervention period.
No emphasis was placed on improving strength, sprinting, or jumping performance throughout the intervention period. The 4-week intervention period was carried out directly after the off-season intermission period, encompassing the 4-week preseason preparation period.

Statistical Analysis

For data processing, the SPSS 18.0 program was used to calculate the average and standard deviation for each treatment item. One-way repeated measurement ANOVA and Paired Student's t-test applied to verify the differences in the pre-Hoff protocol and post-Hoff protocol. T
he post-hoc test for the groups was implemented using a least significant difference (LSD) method. Further, the significance level for verification of the hypothesis was set at $p<0.05$.

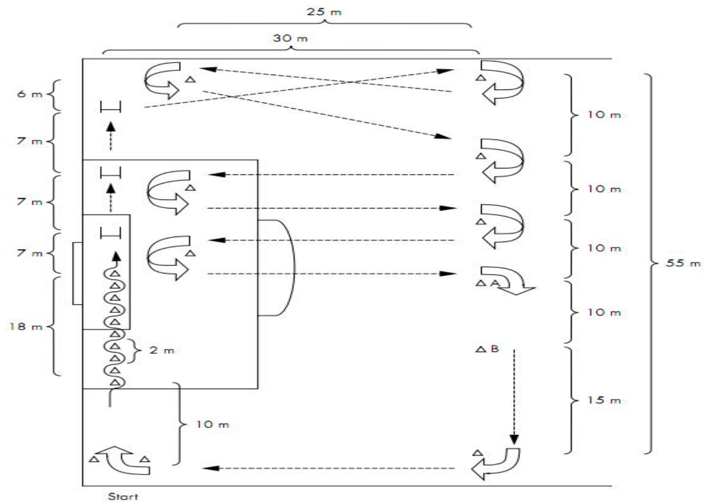

Figure2. Soccer specific dribbling track used for high intensity interval training sessions. Players dribble a soccer ball around the track, lift the soccer ball over the hurdles, and jump over the hurdles. Players dribble backwards with the soccer ball between points A and B.

Results

Changes in aerobic power

The 4 weeks aerobic training intervention manifested significant improvements in Vo_{2max} (table 1) of 5.5% ($p<0.05$). The mean Vo_{2max} increased from 49.14±4.65 to 51.87±5.13 $ml.kg^{-1}.min^{-1}$. Mean body mass was unchanged after the intervention period.

Table1. Changes in VO_{2max} in soccer players.

Variable	pre-Hoff training	post-Hoff training	p value
VO_{2max} ($ml.kg^{-1}.min^{-1}$)	49.14 ± 4.65	51.87 ± 5.13	0.01*

Changes in CPK

Table 2 represents the results of the ANOVA. As shown in Table1, the values of plasma CPK in soccer players increased immediately after performing exercise. The values in pre and post exhaustion time decreased after the 4-week training (figure3).

Table2. Changes in plasma CPK in soccer players.

	pre-Hoff training		post-Hoff training	
CPK (IU/l)	pre-exhaustion	post-exhaustion	pre-exhaustion	post-exhaustion
	193.66±121.57	234.33±136.44*	132.5±56.05**	163.58±62.28*,**

* Significant difference between pre and post exhaustion. ** Significant difference between pre and post Hoff training.

Changes in LDH

As shown in Table 3, the values of plasma LDH increased after exhaustion but decreased after 4-week training in the group (figure 4).

Table3. Changes in plasma LDH in soccer players.

	pre-Hoff training		post-Hoff training	
LDH (IU/l)	pre-exhaustion	post-exhaustion	pre-exhaustion	post-exhaustion
	164.16±27.83	220.16±52.5*	144.16±24.01**	168.33±25.39*,**

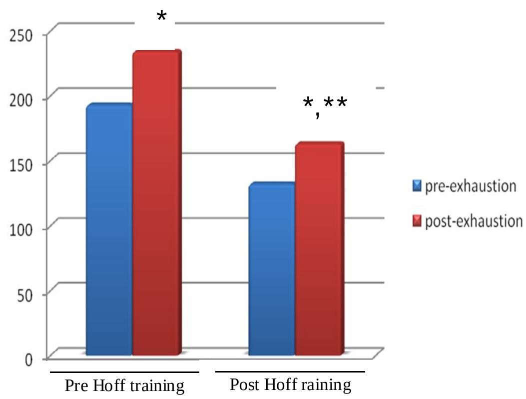

Figure3. Changes in plasma CPK before (pre) and immediately after (post) exhaustion in 12 soccer players. *P＜0.05.

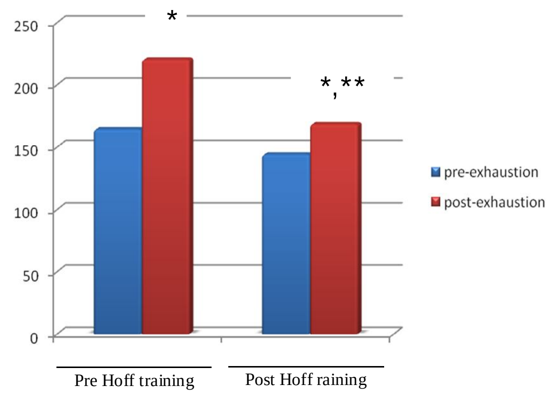

Figure4. Changes in plasma LDH before (pre) and immediately after (post) exhaustion in 12 soccer players. *P＜0.05.

Discussion

Our study proved that 4 weeks of high intensity aerobic interval training with ball caused meaningful reduction of serum LDH level in rest (12%) and exhaustion time (23%). It is means serum level of LDH in the rest time in Pre-Hoff training moved down from 164. 16 to 144.16 IU/l in post- Hoff training.

Meanwhile in exhaustion time, serum levels of LDH moved down from 220.16 to 168.33 IU/l. As to CPK, the meaningful reduction was 30 and 31% for rest and exhaustion periods, respectively. That is in rest time, serum levels of CPK moved down from 193.66 IU/l (before Hoff training) to 132.5 IU/l (after Hoff training).

Meanwhile in exhaustion time, serum levels of CPK moved down from 234.33 to 163.58 IU/l. Irrespective of all restrictions and given the obtained results, probably Hoff training have been able to effect on the serum levels of CPK and LDH in rest and exhaustion time.

Meanwhile parallel to our results, other researches reported that after a exhaustive exercise, exercise causes release of the enzymes in serum (Atland et al., 1964; Czuba et al., 2011, Fowler et al., 1962, Miyama, Nosaka, 2004). As it is proved in present study, one exhaustive exercise is a suitable sample to scale oxidative stress effect on the body and accordingly it was shown that after long high intensity training, trained athletes have less increase in levels of CPK and LDH (Bhagat et.al, 2006).

Present findings are according to that of Fowler et al(1962), Atland et al(1964). They reported that after exhaustive exercise increase in muscular damage markers enzymes in untrained athletes was higher than trained peers. On the other hand, according to the study it was declared that 12 weeks of intensive training as 8 min pedaling on the cycle could not have meaningful effect on the level of serum CPK and LDH. Probably the reason of fail to effect in training ,as these authors declared ,is that duration is more effective in cellular compatibilities driven by muscular damage than exercise intensity and it could be announced that kind of applied protocol can be affect the resulting output (Bhagat et a.l, 2006).

Accordingly it has been stated that CPK release is mainly related to exercise duration and there is a correlation 0.97 between CPK and LDH (Kim et al., 2007).

Thus given the theories in relation to intensity and duration of exercise we could interpret then as follows: As stated, there is a direct relationship between muscular damages markers and exercise duration and intensity (Han et al., 2011, Kim et al., 2007) and in this respect, Hoff training had relatively long duration (4 min) and high intensity (90-95 % maximum heart rate). Of course the mentioned training included eccentric activities such as running, jumping and backward running which everyone of them only cause increase of muscular damage markers in blood (Magalhaes et al, 2010).

Thus, one session of Hoff training could move up LDH and CPK levels in serum as strenuous activities. On the other hand according to studies, it was proved that frequent eccentric activities in some sessions and as more specialized repeat of running in downward in 6 weeks could move down increase of levels LDH and

CPK (Byrnes et al., 1985). Given the results and specifications of Hoff training, it is expected that if these training were repeated, this training likely will reduce the increase of muscular damage markers releases in blood after a session of exhaustive activity. Thus, our results parallel to this theory that repeat of long high intensity eccentric activities could reduce the increase of LDH and CPK levels in serum.

On the other hand, in this study coincided with increase in VO_{2max} (5.5%) from 49.14 to 51.87 $ml.kg^{-1}.min^{-1}$, soccer players showed increase in muscle damage markers. Our findings are in tune with those of previous studies, who also found that Untrained athletes immediately after high intensity activities and exhaustive exercises, have higher blood CPK and LDH levels than trained athletes (Atland et al., 1964; Han et al., 2011).

The main restriction in our study which likely effects on the obtained results in levels of muscular damage markers is that in relation to these variables from control group, blood sampling neglected and the results were reported only based on pre and post Hoff training data.

However, it is evident that the results should be interpreted cautiously, but based on available data no study had measured Hoff training effect on muscular damage markers and this study can be a start point for future researches, so control group will be applied and different protocol length be tested.

Conclusions

In summary, the present study demonstrated that 4 weeks of high intensity aerobic interval training caused significant decrease in muscle damage markers in rest and exhaustion time in soccer players and it was coincided with increase in their aerobic power.

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