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Effect of Fencing Championship on Muscular Damage Indicators in Fencer Females

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Abstract

Introduction: Assessing muscle damage may help to improve the performance of athletes during the tournament. The purpose of this study was to investigate the effect of a fencing tournament on muscle damage markers in fencer females.

Methods: In a semi-experimental research 20 fencer women with mean age 21.59 ± 4.03 years, BMI 20.79 ± 3.13 $kg.m^{-2}$ and VO_{2max} 41.01 ± 4.98 $ml.kg^{-1}.min^{-1}$ were selected purposefully and randomly divided into experimental and control groups. The experimental group competed fencing in a periodically and single-off form. Blood samples were drawn before, immediately after, 24 and 48 hours after the tournament. Statistical analysis of repeated measures and independent t-test were used at $P \leq 0.05$.

Results: The results showed that the differences in CK levels were significant before and immediately after, before and 24 hours after, before and 48 hours later, immediately after and 24 hours later, 24 hours and 48 hours after the tournament ($p<0.05$). Meanwhile, the differences between CK levels immediately after and 48 hours after the tournament were not significant ($p>0.05$). Differences in the levels of LDH before and immediately after, immediately after and 24 hours later and immediately after and 48 hours after the tournament were significant ($p<0.05$), but before, 24 hours and 48 hours after the tournament and 24 hours later and 48 hours after it ($p> 0.05$) were not significant.

Conclusion: In professional fencers, a tournament could lead to muscle injury. This can be useful for fencers and coaches to examine the intensity of the exercises and adaptability of involved muscles.

Keywords: Fencing, Muscle Damage, Creatine Kinase, Lactate Dehydrogenase

Introduction

Muscle damage leads to the appearance of intracellular proteins into the blood, which in the long term cause to reduce the production power, flexibility, and muscle velocity (1). Exercise at the professional level is not always a factor to improve body health due to dehydration, nutrient evacuation, muscular damage, inflammation and increased production of free radicals (2). Free radicals are natural reactive compounds that are produced in the human body and have positive effects (on the immune system and antioxidant defense) or negative effects (on fat, protein, and DNA oxidation) on athlete's performance based on the training load and physiologic conditions (3). To limit the harmful effects of free radicals in intense exercise, the body needs to enzymatic defense systems (such as catalase, glutathione peroxidase, superoxide dismutase) and non-enzymatic defense systems (such as vitamins A, C, E) (4). However, if the production of free radicals exceeds more than the ability of the body's antioxidant system to disable oxidative stress, cellular and muscular damage may occur (5). Researchers have found that muscular damage due to exercise is associated with the disruption of unusual muscular structure and localized ischemia (6). Plasma creatine kinase

(CK) and lactate dehydrogenase (LDH) levels are associated with inflammation, muscle and cartilage damage. Lactate dehydrogenase is an enzyme found in the cytoplasm of all body cells with different levels and accelerates the conversion of pyrovic acid to lactic acid or vice versa. The mechanism of cellular secretion of this enzyme is still unknown; however, it is usually due to structural changes in muscle tissue following intense physical activity. Following a moderate to exhausting exercise, the level of lactic acid in the muscle and blood increases **(**7**)**. This enzyme also has an effect on production of inflammatory conditions for muscle fibers, in addition to its activity in the production of lactate and energy (8). Some researchers have reported an increase in lactate dehydrogenase levels due to muscle fiber membrane damage after physical activity (9). On the other hand, researchers have reported the highest level of creatine kinase enzyme in muscle tissue after injury. Therefore, the level of the CK enzyme can be considered as a biochemical marker of muscle fiber damage (10). Levels of lactate dehydrogenase and creatine kinase enzymes have been studied on some athletes but no research has ever been done on fencer athletes. Fencing is one of the fastest sport with most explosive attacks that can lead to muscular damage. In addition to various concentric and eccentric movements in this sport, effect of the sword hit on the athlete's body, cause to soreness and bruise (Especially during the tournament days that the fencers participate in several competitions). Despite the archaism of this sport, researches on fencing are very limited. While, if it is possible to reduce the disruptive effects of oxidative stress on fencerبs muscle, it may be possible to improve their performance in subsequent competitions or shorten the recovery time. These are critical for professional fencers and their coaches because of the extraordinary speed of this sport and some wonderful events occur in the last seconds. If a fencer minimizes physical limiting factors (such as pain and oxidative stress) and his/her mind focuses on match strategy, it is more likely to be success. The effect of the participating in fencing competitions with respect to its specific motor pattern on muscular injury, LDH and CK levels have not been studied yet; therefore, this study intends to survey the levels of muscle damage markers after a fencing tournament.

Methods

This research is semi-experimental and applied paper. The statistical population consisted of 64 fencer women participating in the first class league of Iran. The sample consisted of 20 fencer females selected purposefully and randomly divided into experimental (n=10) and control (n=10) groups. The maximum oxygen consumption (VO_{2max}) was calculated from the women formula (11). Entry criteria included: a) three-year experience in fencing sport and b) exercising at least three days a week. Exit criteria were determined by using drug and supplements, smoking, history of blood diseases or diseases affecting immunity system, infection and allergic conditions. On tournament day, all subjects were in premenstrual days. To collect the information about the individual characteristics of the subjects, data sheets and consent form were completed and signed by the participants. Subsequently, subjects were provided with explanations to initial measurements and participation in competitions. The tournament was initially held on a periodic regular basis in two 5-person tables and then with single-off form. Players were allowed to arbitrarily drink about a liter of water during the tournament (12). Before the study, the subjects were asked to eat on average, according to their previous dietary habits, almost in the same manner, two days before the test. On the tournament day, players arrived at the stadium and ate a standard breakfast to provide their energy (13). Heart rate was recorded by Polar pulse rate recorder (Polar Electro, Kempele, Finland).First blood sampling was drawn at 7 to 9 am, while the subjects were 12 hours fasting from their right elbow vein and subsequent samples were collected immediately after the fencing competition, 24 and 48 hours after (5 ml each time). Plasma levels of lactate dehydrogenase and Creatine Kinase enzymes were evaluated by Pars Azmoon kits with sensitivity 5 units and 1 unit respectively by Hitachi Auto Analyzer (902 model, manufactured in Japan). During the research, none of the participants was omitted. On the competition day, 10 fencers of the experimental group were divided into two groups of 5-person according to the ranking that they had achieved in the last season of the national championship and each person in her group played four matches periodically and all the points were recorded. Each periodic game was 4-minute and 5-beat. Then, every 10 fencers in experimental group received a ranked number based on the number of victorious games and hit points and they went to the single-off tournament section and the tournament continued until the final. Each single-off match consists of three 3-minute sections with a 1-minute break and 15 beats. They did not participate in the tournament on the day of the research, and did not have physical activity on that day. Statistical analysis was performed using SPSS software version 22. Descriptive statistics were used to determine the mean and standard deviation. To determine the normal distribution of data, the Kolmogorov-Smirnov test was used, and to compare the inter-group variations repeated measures ANOVA and Bonferroni's post hoc test and to compare the variations between groups, independent t-test were used at the significance level of **α**< 0.05.

Results

The descriptive information and physical characteristics of the subjects are presented in Table 1. Independent t-test showed that there was a significant difference between the experimental and control groups in the CK levels 24 hours after the fencing competitions (p = 0.001); Also, there was a significant difference in the LDH levels immediately after the event between the two groups (p = 0.014). The levels of creatine kinase (CK) enzyme increased significantly in the experimental group after the fencing competitions (p = 0.011). The results of the Bonferroniبs test in the experimental group indicated that difference of CK levels before and immediately after the tournament (p = 0.04), before and 24 hours after the tournament (p = 0.010), before and 48 hours after the tournament (p = 0.032), immediately after and 24 hours after the tournament (p = 0.038) and 24 hours after the tournament and 48 hours after it (p = 0.048) were significant. Meanwhile, there was no significant difference between CK levels immediately after the tournament and 48 hours after it (p = 0.651) (Fig. 1). The level of lactate dehydrogenase enzyme in the experimental group after the fencing competitions increased significantly (p = 0.043). The results of Bonferroniبs post hoc test in the experimental group showed that the difference in LDH levels before and immediately after the tournament (p = 0.011), immediately after and 24 hours after the tournament (p = 0.009) and Immediately after and 48 hours after the tournament (p = 0.021) were significant but LDH levels before and 24 hours after the tournament (p = 0.441) and before and 48 hours after the tournament (p = 0.317) and 24 hours later and 48 hours later (p = 0.643) were not significant (Figure 2). Mean values and standard deviation of creatine kinase levels before the tournament, immediately afterwards, 24 and 48 hours later in experimental and control groups are presented in Fig. 1. The mean values and standard deviation of lactate dehydrogenase levels before the tournament, immediately afterwards, 24 and 48 hours later in the experimental and control groups are presented in Fig. 2.

Table 1. Mean and standard deviation physiological parameters of subjects

Groups	Experimental	Control	p
age	22.23±4.17	20.95±3.89	0.061
BMI ($kg.m^{-2}$)	21.48±3.17	20.11±3.09	0.087
Vo_{2max} ($ml.kg^{-1}.min^{-1}$)	41.25±5.11	40.77±4.86	0.212

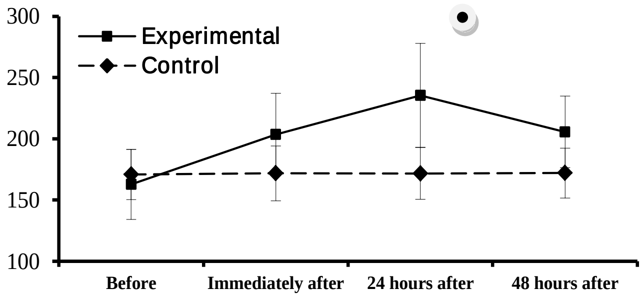

Fig 1. CK levels (IU/L) in experimental and control groups
: Significant different

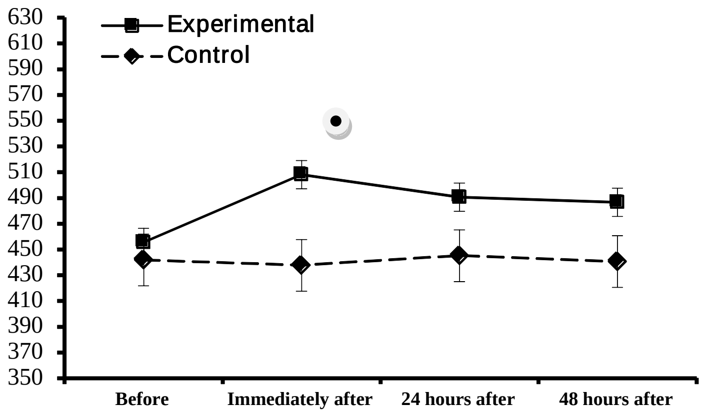

Fig 2. LDH levels (IU/L) in experimental and control groups
: Significant different

Discussion

The results of the study showed that a fencing tournament could increase muscle damage in fencer women. This increase in the creatine kinase enzyme immediately after, 24, 48 hours after the tournament and in the lactate dehydrogenase enzyme immediately after the tournament in the experimental group was significant ($p<0.05$) compared to the control group. Even though in many studies, lactate dehydrogenase and creatine kinase enzymes have been used to assess muscle damage, but both the LDH and CK enzymes are known as indirect indications of muscle damage. Some studies have achieved similar results with this research (14). Baradaran *et al.*

showed that increased intensity of exercise led to elevate levels of lactate dehydrogenase and free radicals in female athletes (15). Silvestre *et al.* (2017) showed that a severe resistance training session on the ladder in rats increased levels of LDH and CK (16). Paraiso *et al.* (2017) showed that an acute swimming exercise session increased the levels of CK and LDH in national team players (17). Hosseini Nejad *et al.* (2017), with a study on inactive women, found that immediately after the first session of acute resistance training with 85% of 1RM, the maximum levels of LDH and CK increased significantly (18). Karamizrak *et al.* (19) examined the differences in the levels of creatine kinase and lactate dehydrogenase and aldolase activity after maximal exercise in athletes and showed that maximum intensity of exercise could cause microscopic muscle damage and inflammation. Other studyhas shown that with increasing intensity or duration of training, the levels of CK and LDH enzymes increase significantly (20). Saengsirisuwan *et al.* (21) examined the muscular injury during training and after the Thai boxing contest. The results showed that in the blood serum of the experimental group of boxerبs levels of AST, CK, and LDH were significantly higher than the control group. Studies have shown that increased levels of these enzymes may indicate tissue damage after training (22). Also, increased levels of these enzymes in the blood serum after exercise have correlation with the amount of hypoxia lesions and the expansion of anaerobic energy production (23). Another study showed that muscle contractions cause to damage muscle fibers, connective tissue and cell membranes, that leading to increased levels of CPK and LDH (7). Margaritis *et al.* (24) in a study about triple trials champions, showed that changes in the muscle injury markers would be significant before the activity up to four days later. In return Matsus *et al.* (25) did not see any significant increase in levels of these enzymes after an unloaded exercise session with 10 repetitions and one-minute rest. The type, intensity and duration of exercise and the time of recovery can affect the release of these enzymes. Fencing sport has eccentric explosion activities in the hands and feet and concentric ones (return to the guard after any attack) and every fencer should bear the weight of his/her sward in one hand and constant angles on the ankles, knees, wrists, elbows, scapula, neck and even fingers, and moving and jumping on the metal track (most of the fencers in addition to these two movements, have the habit to do dance with their feet over allowed time)and they use energy from both aerobic system (for being on guard and go back and forward) and anaerobic system (for attacks and explosive anti-attacks).On the other hand, eccentric contractions result in the production of free oxygen radicals, lipid peroxidation, muscle tissue damage and subsequent inflammatory processes (23). Following intense eccentric activity, the junction area of muscle and tendon may be damaged. As shown in Figures 3 and 4, the fencer struggles (as much as he/she can) to do quick and huge attacks continually, while the landing of the legs is also on a metal plate, that turns back the pressure to the legs. These factors can be attributed to the increased levels of these enzymes in fencer women. On the other hand, as glycolytic metabolism in people with high activity is more than inactive people, this may indicate a higher concentration of CK and LDH in the experimental group than in the control group after the tournament because, as mentioned, some parts of the explosive movements in fencing supported by anaerobic energy production system. In addition, some studies have suggested that there is correlation between CK and LDH as cellular damage indicators with cytokines such as IL-6 and TNF-**α**. Boussouar *et al.* (26) reported that TNF-**α** could have a very effective role in stimulating the expression of LDH. Also Yamin *et al.* (27) reported that IL-6 and TNF-**α** played a significant role in stimulating the activity of CK and LDH after eccentric and resistance movements.

Therefore, if it is possible to study the concentration of some anti-inflammatory cytokines, simultaneously with levels of CK and LDH, changes in the variables can be better explained. This matter could be one of the limitations of this research because the cytokines did not measure. In a study, it has been shown that performing intense and prolonged exercises, regardless of the proper recovery time, damaged the muscle fibers during contractions, the internal degradation of muscle fibers and connective tissues occurred and cause to inflammatory responses, macrophage infiltration, release cytosolic and cytoplasmic enzymes such as AST, LDH and CK, followed by pain symptoms, motor limitation and biochemical changes and muscle spasm (29). Muscular injury may also be due to irreversible stretching of sarcomeres (29). As Noakes (30) expressed an increase in LDH levels after exercises related to myofibriles damage due to the destruction of Z lines in some specific sarcomeres. With respect to the high speed of performance in fencers and sudden opening the joints (epecially elbow and knee joints), damage to the Z lines may have occurred in the leg muscles and especially the armed hand. Increasing CK levels, especially during exercise and recovery, reflects the Leakage of proteins through the muscle membrane. Factors such as age, gender, body fitness, season, and exercise are associated with fluctuation of these enzymes (31).The production of free oxygen radicals and lipid peroxidation and ultimately muscle tissue damage can lead to calcium accumulation in the sarcoplasm and cause disorder in cellular respiration to some degree and disrupted the production of adenosine triphosphate (ATP) then the neutrophils in the circulation increased and 6 to 12 hours after injury, macrophages accumulate in the inflamed area and cause to produce active histamine. However, the magnitude of macrophages and monocytes reaches the maximum levels 48 hours after injury. When inflammation occurs, the macrophages stimulate the release of prostaglandins which causes nervous terminals become susceptible to mechanical, chemical, and thermal stimulation (32). In the current study, the CK levels peaked 24 hours after the tournament, the type of action, the time of matches and the rest between games can affect the above factors. The accumulation of histamine, quinine and potassium, which is associated with phagocytosis, cell death, edema and localized heat produced by active tissue, leads to the activation of pain receptors in the muscles and muscle-tendon joints. These processes can lead to release of CK, LDH and AST, and can cause pain and suppress (33). Muscular metabolic disorders are thought to lead to release some cellular components through a cascade of events that begin with ATP evacuation and leads to leakage of extracellular calcium ions into the intracellular space due to impairment in the function of sodium-potassium pump and calcium pump. The proteolytic activity of the enzyme in the cell can contribute to the progression of protein degradation and spill the contents of the cell into the blood. The onset of metabolic and muscular dysfunction processes is not fully understood and it is thought to be composed of a complex range of events associated with increased oxidative stress, inflammation and immune response (34). Of course, in many cases, mild to moderate injuries do not cause a problem in healthy people and the body can clear muscle cell compounds from the blood and return their levels into the basal levels in 7 to 9 days (35). A study conducted by Brewster *et al.* (36) suggested that high levels of CK in the absence of muscle damage or other pathological conditions could reflect CK activity in tissue following over normal activity. CK level can increase the available energy of the cells and improve myofibril contractile responses. On the other hand, AMPK is passive at the time of rest or inactivity, and metabolic processes are focused on synthesis, storage and accumulation. During physical activity, the ATP level decreased and AMPK is activated and triggers a range of physiological and biochemical processes that require energy (37). AMPK is a key regulator that can phosphorylase CK and is sensitive to Cr / PCr ratios. At the beginning of physical activity, the initial muscle ATP, supplies by the Cr-PCr shuttle. So that PCr + ADP converts to Cr + ATP, until PCr evacuated. When physical activity continues and ATP is increasingly provided by oxidative phosphorylation, the levels of ATP rise slowly because both cytosolic MtCK and CK consume energy to reproduce PCr. Due to the role of AMPK during exercise to limit energy consumption by unnecessary systems, it is likely that the CK level will increase. Although PCr resynthesize is greatly reduced during extreme sports, AMPK is still needed to maintain Cr / PCr ratios. At this stage, it is believed that CK exit from cytosol to maintain its ratio. If this happens, elevated levels of CK after normal physical activity indicate a natural metabolic reaction rather than muscle damage (38). Such a system does not work alone and is part of a complex processes, and it is only when all of this processes are comprehensively understood then changes related to muscle activity can be interpreted. Investigating the amount of pressure to muscles during the tournament is necessary for coaches and athletes to design training plans, especially in selective competitions with different levels because with respect to the type, intensity and duration of training, it can increase the performance or reduce it (39). It is suggested that, as far as possible, coaches simulate the conditions of a tournament, in such a way that players be in main competitions position. This could be beneficial for muscle adaptation and reduces damages.

Conclusion

It seems that in professional fencers, a tournament could lead to muscle injury. This can be useful for fencers and coaches

Fig 3. Legging situation in fencing attack

Fig 4. Legging situation in fencing flash

to examine the intensity of the exercises and adaptability of involved muscles.

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Ethical issues

Not applicable.

Authors' contributions

Only one author contributed to the writing and revision of this paper.

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