The effects of acute high intensity interval exercise of judo on blood rheology factors

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Abstract. Hemorheology is a branch of biology, the science of deformation and blood flow against force and the pressures being on it. The aim of this study was to investigate the effects of acute high intensity interval exercise of judo (SJFT) on blood rheology response factors in trained judokas. For this, 12 judoka with at least two years of regular training voluntarily participated in this study. All subjects performed Special judo fitness test (SJFT) and blood samples collected before, immediately after and a half hours after the test. The results showed that plasma volume and red blood cell count was significantly decreased immediately after exercise (p<0.05), and the number of white blood cells, platelets and hematocrit were significantly increased after protocol (p <0.05). But all variables fall to primary level half an hour after protocol except white blood cells. The current study showed that the interval intense activity of judo can make an effective response in blood rheology; these changes are transient and probably due to reduced plasma volume and after recovering from exercise returns to baseline level.

Keywords. Blood cells, blood rheology, hematocrit, judo.

Introduction

Hemorheology is a branch of biology, the science of deformation and blood flow against force and the pressures being on it. Blood viscosity, plasma viscosity, fibrinogen, hematocrit and red blood cell aggregation and flexibility are an important determinant of blood Hemorheology. Changes in mentioned factors with an impact on the viscosity of the whole blood could defeat oxygen flow to body tissue (El-Sayed et al., 1998). Blood Responsibility for oxygen transport in body is an important role of blood. Blood studies provide that the effectiveness of regulation of homeostasis or maintain stability of main parameters of the body's internal environment could be recognized as blood role. Adaptation is associated with muscle activity, and total plasma volume and total blood volume changes. Plasma volume changes can affect the concentration of substances in the blood, so, could change the outcome of metabolites, substrate, and hormones in the blood. Also, muscle activity causes changes in blood cell counts and specific distribution in different cells (Kraemer et al., 2002).

In recent years, a variety of physical and physiological changes caused by blood hematology attracted the attention of many researchers and experts. Blood rheology in the past three decades has been of interest to exercise physiologists and attention to physical activity and exercise is increased related to health achievements, also to assess the impact of physical activity on blood rheology some researches was carried out (Kraemer et al., 2002). Metabolic and physiological changes occur in the human body after a body exercise in order to meet the conditions of the stress of exercise and performance. Exercise has beneficial effects on metabolic status and body composition as factors for prevention from cardiovascular disease; it is known that the rate of deaths from cardiovascular events reduced due to physical activity. Regular exercise training has an impact on cardiovascular disease by lowering levels of fibrinogen, plasma viscosity, and blood viscosity as well as the increase in plasma volume and blood flow, which increases the amount of oxygen supply to the muscles involved in the activity (Yalcin et al., 2000). As a result, regular exercise training by hemorheological adaptations could decrease the risk of cardiovascular events and reduce complications caused by it (Şentürk et al., 2005).

Historically, leukocytosis -increased white blood cells in response to exercise is approved in past decade, many studies have been conducted In relation to the acute effects of exercise on red and white blood cell. Blood flow and plasticity and concentration of red blood cells are fundamental determinant of hemorheology. Blood flow in large vessels and red blood cell form and deformability in smaller vessels are the main determinants of blood streaming. The concentration of fibrinogen in physical activity increased the concentration of red blood cells (Şentürk et al., 2005). On the other hand several studies have concluded that exercise-induced oxidative stress and release lactic acid is inversely related to the formation of red blood cells and causes friability (Connes et al., 2008). The short-term (acute) and long term (adaptations) physical exercise activities ranging from endur-

ance, high intensity interval and resistance training on blood parameters have been studied. Wide range of adaptations after intense interval training has been shown that these adaptations include increased glycogen content of skeletal muscle in recovery time and improve maximum glycolytic and oxidative enzyme activity and the H+ buffering capacity. As well as increase and no change of maximum oxygen consumption (VO2max) during exercise have be illustrated after high intensity interval training (HIIT) (Connes et al., 2009). However, studies on the effect of intense interval training and resistance training on hematological parameters are limited.

For example, Kordie et al. (2012) conducted a study, they determined the effect of anaerobic exercise on blood rheology of active young women, after randomization of subjects to control and experimental groups, an anaerobic exercise (RAST) were performed and hematology variables were studied. Blood samples were collected from the experimental group before, immediately after and two hours after the protocol. The results showed that hematocrit and hemoglobin were significantly increased immediately after exercise although, two hours later decreased significantly. Number of red blood cells immediately after the exercise had significant decrease and two hours later there was a significant increase. Plasma volume reduced significantly immediately after protocol but returned to baseline after two hours of recovery. However, changes in fibrinogen and erythrocyte sedimentation rate were not significant in either case (Kordie et al., 2012). Cesur et al. (2012) studied the effect of indoor rock climbing activity on blood parameters. These researchers found no significant changes in hematological parameters such as HCT, HB, WBC and PLT. Dastbarhagh et al investigated the impact of a high-intensity interval training in hypoxic and normoxic conditions on WBC and blood cells in response to exhaustive exercise. Their results showed that the hypoxia caused a significant increase in the red blood cells, hemoglobin and significantly reduced platelet aggregation compared to the normoxic environment (Dastbarhagh et al., 2015). Ghanbari et al. (2011) conducted a study that aim was to investigate the effects of one session of circuit resistance exercise on hematological parameters in physical education students, the findings revealed a significant increase in MPV, P - LCR, PLT, MCV, WBC, but, RDW was significantly decreased And changes PDW, MCHC, MCH, HCT, HGB, RBC was not significant in response to circuit resistance exercise program (Ghanbari et al., 2011). Ahmadi Zad et al. (2014) investigated on acute effects of resistance exercise on the main indicators hemorheology and their results showed that plasma volume in response to resistance exercise decreased 10%, but, hematocrit, hemoglobin and the number of red blood cells had a significant increase. Plasma proteins showed a significant increase in response to exercise. The authors concluded that these changes were transient and returned to normal after 30 minutes of recovering from exercise and this phenomenon can be attributed to the concentration of the blood as a result of exercise.

Between different sports, according to the analysis of sports experts judo competition is high-intensity interval exercise, heart rate and blood lactate concentration during the competition increases a lot. Special judo fitness test is a periodic testing of the judo that modeled from judo competition, researchers and coaches have been assessed judokas performance by this special test (Sterkowicz et al., 2001). Franchini et al. (1999) in study announced that it has sufficient reliable test. This test has sufficient sensitivity to physical exercise training and athlete's progression could be monitored by this test in the preparation period. Also, this test has a high correlation with performance in a real competition (Franchini et al., 2011). To this time, several studies have been conducted with topic of hematological changes in response to martial arts competition or training. For instance, Arazi et al. (2009) in a study determined the effects of a preparation and skill-specific training session on Hematologic variables of elite kung fu practitioners. The results of the research showed that, HGB, HCT, RBC and MCV was a significant decrease but MCH and PLT significantly increased after Kung Fu training session (Arazi et al., 2009). In another study Zar et al (2009) investigated the effects of moderate exercise, on peripheral blood neutrophils in male judo players that run on the treadmill with a moderate intensity. The neutrophils were increased, but the increase was not statistically significant. Most studies of hemorheology have been investigated short-term and long-term effects of endurance exercise. In relation to doing interval training and its effect on hemorheology parameters just few studies conducted and different results depending on the capacity of sport, intensity, duration and type of activity may be observed. Although the studies that have been conducted in the field of martial arts are very limited, this is the first study that investigated on hemorheology parameters after a high-intensity intermittent exercise (HIIE) of judo.

Method

Study population

The participants were 12 male judokas from Iran (mean ±standard deviation: 23.67±3.10 years old, 176±3.22 cm of height, 71.6±7.9 kg of body mass and at least two years of regular judo training background). All of them ranking from Dan1 to Dan3 and were in preparatory period of training. None of them was taking medications or supplements. They were notified about the potential risks involved and gave their written informed consent form. This study was approved by the Ethic Committee for human experiments at faculty of physical education and sport science of Shahid RAjaee University.

To minimize the effect of heavy exercise, Subjects were asked didn't have any extreme physical exercise 48

hours before the SJFT. After 5 minutes of warm-up, SJFT performed and blood samples collected before, immediately after and a half hours after the test. 10 ml of blood was collected from each subject with the use of needles when subjects were at sitting position. Blood samples immediately allowed to flow tubes containing EDTA anticoagulant agent, and immediately transported to the laboratory. Hematological variables (RBC, WBC, HGB, HCT and PLT) were measured using a cell counter (Sysmex kx-21) analyzed. Anticoagulant agent was added to the blood for the measurement of erythrocyte sedimentation rate (ESR), when red blood remained motionless then it deposited. To determine changes in plasma volume, Dill and Castile equation was used (Dill and Castile, 1974).

$$\%\Delta pv = \{HB1/HB2 + (100 - HTC2)/(100 - HTC2) - 1\} \times 100$$

Special judo fitness test

Special judo fitness test (SJfT) was applied as described elsewhere. The test was performed in 3 series of 15, 30 and 30 s with 10 rest interval between them. During test series, the athlete throws two other judoists (6-m apart from each other) as many times as possible using the ippon-seoi-nage technique. Heart rate (HR) was measured immediately and one min after cessation of the test by sport tester device (polar electro, Finland) and an index was calculated (index=HR immediately after test + HR one min after test/total number of throws). Thus, a lower index indicates better performance (Arazi et al., 2013).

Statistical analysis

Values were expressed as means± SD. The normal distribution of the data was checked using the Kolmogorov-Smirnov test. After confirming normal distribution, the difference between the mean of the data was tested using one-way ANOVA with repeated measures was used to evaluate within group differences in pre- and post-blood parameters level in three series, Tukey method was used for post-hoc comparisons. The P value was significant <0.05. All statistical tests were performed using SPSS software (version 18) and Excel (Office Word 2007 version) was used to draw figures.

Results

Changes in blood rheological variables are shown in Table 1. According to this study, a significant increase in hematocrit was observed immediately after the test, but 30 minutes later it decreased significantly (p<0.05). Hemoglobin concentrations were significantly increased immediately after the test and at the end of 30 minutes of recovery time (p<0.05). The number of red blood cells immediately after the test compared to pre-test showed significant reduction (p<0.05), but 30 minutes later it was observed a significant increase. Changes in red blood cell

sedimentation rate in any of the phases immediately and 30 minutes later than the test was increased but it weren't statistically significant. Plasma volume immediately after the test reduced compared to pre-test level significantly (p<0.05), and 30 minutes after the test had a significant increase.

Table 1. The mean (+ standard error) values of hematological variables at rest, immediately after exercise and after 30 min of recovery (n = 12).

Variable	Rest	Post-Exercise	Recovery
RBC Count (Lμ106)	5.83 ± 2.44	5.21 ± 3.01*	5.58 ± 3.89 ¥
Hemoglobin (g/dl-l)	15.21 ± 3.21	15.17 ± 4.48	15.26 ± 2.92
WBC Count (Lμ103)	6.12 ± 1.23	69.47 ± 2.86*	6.78 ± 1.12 *
PLT Count ((Lμ103)	225.86 ± 16.47	231.29 ± 13.74*	226.75 ± 8.69 ¥
ESR (mm/1ˢᵗ h)	12.8 ± 4.32	12.7 ± 3.44	12.8 ± 4.04
Plasma Volume Change (%)	-	- % 5 ± 2.2*	+ % 9.01 ± 3.4 ¥
Hematocrit (%)	43.4 ± 6.38	46.04 ± 7.98 *	44.62 ± 9.39 ¥

* Significant differences to rest; ¥ Significant differences to post exercise (p<0.05).

Discussion

The current results showed that plasma volume decreased due to high intensity interval activity (% 7), And this decline may be due to increased blood viscosity as a result of the transition exercise-induced fluid from the blood into the interstitial space, it returned to baseline level even slightly more higher, 30 minutes after the workout. This finding is consistent with the findings of Whittlessey et al. (1996) observed that the reduction in plasma volume after the Wingate test, also, with the results of Kordie et al. (2012) that reported a significant decrease was observed after the RAST anaerobic test is consistent. As well, our findings are agree with and Ahmad Zad et al. (2014) that reported The 30-minute recovery after doing protocol could returns these variables to the primary levels. To recent, investigations on rheological parameters response to high-intensity anaerobic exercise are scarce. The limited evidence suggests the overall viscosity of the blood and plasma in response to different exercise protocols increases. The overall increase in hematocrit and blood viscosity increase is mainly attributed to plasma viscosity, density while the deformability of red blood cells remains unchanged (Close et al., 2004).

In relation to the hematocrit, it was clear from our findings that hematocrit increased in response to exercise and 30 minutes after recovery returned to its basic state. Perhaps high intensity interval exercise (SJFT) caused blood fluids shifted toward interstitial tissue and the phenomena that occur concentrates the blood so temporary can increase hematocrit. These findings are in agreement with the results of most researchers who reported an increase in hematocrit after exercise. Some researchers reported that physical activity session increased hematocrit that is in line with the results of this study, (Arazi et al., 2000; Robertson et al., 1998; Kordie et al., 2011; Ahmed Zad et al., 2014). However, some studies have reported decreased hematocrit in response to stren-

uous physical exercises. Hematocrit increase may indicate blood thickening and transmission fluids outside of the blood vessels. also, it was reported the main mechanism for blood thickening after the exercise and increasing the hematocrit and plasma viscosity is an overall increase in hematocrit immediately after the implementation of the present Protocol, possibly associated with a decrease in plasma volume through the drainage of fluid from the vascular system into the inner space cellular and store water inside the muscle cells which then recover to its baseline (Ahmed Zad et al., 2014).

The results showed that the number of red blood cells decreased temporarily in response to SJFT significantly and after rest goes back to the basic state. This response is probably due to the high intensity exercise could make high blood pressure and increase red blood cells treated with intravascular hemolysis in vessel wall more and more lead to the loss of red blood cells defeats. Some researchers agree with these findings (Ahmedizad et al., 2010), but Cesur et al., (2012) and Ghanbari et al. (2011) report is inconsistent.

The level of WBC increased immediately after exercise and the value even after 30 minutes it was upper than resting level and wasn't return to its basic state. These findings are in agreement with Arazi et al 2009 findings. The white bloods cells are involved in all aspects of the immune system. This role may apply directly through the cells or indirectly through the release of soluble factors. Physical activity causes significant changes in the number and distribution of groups of white blood cells in circulation (El-Sayed et al., 1998). In addition, it may make changes in the proliferation of white blood cells. One of the dramatic changes during physical activity can be seen is leukocytosis (or increase the number of white blood cells circulating in the blood). The number of circulating white blood cells may be increased to four times to rest, after stopping physical activity its level may remain high, its level may even remain high for several hours after the completion of certain types of activities (El-Sayed et al., 1998; Yalcin et al., 2008). The current study also found that after 30 minutes of rest WBC level didn't return to basic level. In general, it seems that the leukocytosis is directly related to exercise intensity and duration but inversely proportional to the fitness level of the individual. Fitness level may be the most important factor (El-Sayed et al., 1998). Close et al., 2004 reported that running on a treadmill with the gradual increase in incline and maximum oxygen consumption by 65% compared to running on a treadmill with incline at zero and at 65% of maximal oxygen uptake is significantly increased white blood cells (Close et al., 2004). So they stated that type of exercise also can play a role in increasing or decreasing of white blood cells.

The results of this study showed that high intensity intermittent exercise of judo had no effect on erythrocyte sedimentation rate. These results are agree with Kordie et al. (2012) findings, that they reported no significant changes in the erythrocyte sedimentation rate after the RAST anaerobic test. It is also consistent with the findings of (El-Sayed et al., 1998). But Ajmani et al. (1997) found a significant reduction in the long-term monitoring of WBC after exhaustive endurance exercise. It is likely that duration of exercise can affect ESR, SJFT likely because of periodic high intensity and short duration property couldn't causes significant changes.

The results of this study showed a significant increase in blood PLT, this finding is consistent with Arazi et al. (2009), and Ahmad Zadeh et al. (2014) findings but disagree. Cesur et al. (2012) found a significant increase in the PLT after a rock climbing session. This finding is consistent with a history of extensive research and texts in this case. Studies have shown that secretion of epinephrine causes a strong contraction of the spleen (storage for about 30 percent of the body's platelets) and where high intensity exercise like SJFT may increase epinephrine levels it would be an excess of platelets.

As was seen in the current study, high-intensity intermittent exercise or contest of judo is considered a serious challenge to the hemorheological state, Since some of these responses potentially could jeopardize athletes health and performance, it is recommended to trainers, coaches and athletes spread their insight about blood variables response and adaptation to exercise training and scientists conduct further research to overcome to the hematologic responses that are Attenuator of health and performance, like loss of hemoglobin and etc. that occurs immediately after high-intensity exercise like SJFT.

Acknowledgements

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