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Effects of Cold-Water Immersion on Muscle Damage and Function in Male Soccer Players after Soccer-Like Competition

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ABSTRACT

One of the most important concerns for coaches and athletes of football field is the limited interval between sport activities for physiological recovery and restore muscle to condition before exercise. Therefore, present study has been conducted aimed at examining the influence of recovering in cold water on some male soccer player's functional and muscle damage indexes, following a quasi-football game, among Arias Athletic and Cultural Club in Tehran, Iran. Statistical population of the current study consists of soccer players ranging from 18 to 29 years of age and statistical sample includes a number of 30 male soccer players available in Arias Athletic and Cultural Club. Recovery in cold water is independent variable and muscular damage indexes include Serum Creatine Kinase and Serum dehydrogenase and functional indexes, including functional power and muscle strength, are considered as dependent variables. Findings of the study indicate that lower CK was seen in group of recovery in cold water than control group after 24 hours of recovery period. Significant reduction in LDH level was only observed for group of recovery in cold water than control one after 24 hours recovery period.

After 24 hours recovery period, significant difference was seen in Sargent Jump value for group of recovery in cold water than control one. For hand claw power, type of recovery has no impact on hand power during various steps of measurement.

KEYWORDS: *recovery, soccer players, muscle damage*

I. INTRODUCTION

Most players in a 90 minute soccer match usually run 10 to 12 kilometers at an intensity close to anaerobic threshold (80–90% of maximal heart rate or 70-80 percent of the maximal oxygen uptake) (Hoff et al, 2002). Regarding the nature of football, this sport is classified as an intense and periodic group exercise, the type of activity changes every 4 to 6 seconds, and professional players have roughly 1,350 movements in a football match, which involve 220 running movements at high speed in short distance (Mohr et al, 2005). The major part of the players' activity during the 90 minutes, are light and aerobic, and less of their activities are intense and anaerobic, but these low percentages determine the outcome of the match and the difference between good players and other players (Donald, 2009).A tough tournament or competition challengesathletes' physical, psychological, and physiological positions. After intensive muscular exercise, structural muscle damage that is a major limiting factor for muscle activity, even for athletes who have not been injured, is observed (Ascensao et al, 2011).

One of the main attributes of muscle injury and inflammation due to exercise is the increased vascular permeability. Muscle soreness following exercise is in two phases: 1. immediately after exercise that is caused by edema in the tissue or metabolic wastes; and 2. delayed soreness associated with inflammatory responses and muscle injury (Van Wyk et al, 2009).

Strenuous exercisesoften cause inflammatory responses (Lambert and Tee, 2007). This inflammatory response is in the form of stress or muscle injury. Muscle fibers and connective cells release certain molecules (cytokines) into the bloodstream (Villalta and Tidbal, 2010), which subsequently affects inflammatory cells (Adams et al., 2011). This process initiates a positive feedback mechanism for inflammatory response characteristics, resulting in stress or damage in the formation of specific molecules and the rapid activation / penetration of inflammatory cells into muscle fibers during exercise. This inflammatory response is necessary to clarify any structural damage that may occur, and may be important for the adaptive response of skeletal muscle to exercise (Villalta&Tidbal, 2010).

Such exercise-induced muscle damage (EIMD) is characterized by decreased isometric muscle strength, change in joint motion, changes in muscle diameter, and muscle protein transfusions (Jakeman et al., 2009). CreatineKinase (CK) and Lactate Dehydrogenase (LDH) are two enzymes that play a vital role in the metabolism of skeletal muscle, especially in severe muscle activities.These enzymes leave skeletal muscle and enter the bloodstream during damage. Therefore, these two enzymes are known as physiological indicators of muscle damage. The release of these two enzymes from the intramuscular medium toward the bloodstream indicates structural damage to muscle fibers (Brancaccio et al., 2008).

Exercise takes several days or a week, but microscopic and fine muscle damage probably does not cause immediate pain. Soreness may be delayed until 48-72 hours after the end of the exercise, as it may cause biochemical changes; therefore, muscle activity can alter the blood concentration of certain cellular enzyme such as CK and LDH. High plasma levels of these enzymes are commonly used as indicators of muscle tissue damage.

One of the main concerns of soccer coaches and players is the limited distance between activities and sports competitions for physiological recovery andrestoration of muscles to pre-exercise condition. Additionally, soccer players sometimes have to compete on consecutive days or even on a single day. In addition to theintensive activities, it imposes a lot of pressure on the musculoskeletal system of the athletes, which ultimately leads to a decline in their performance. Coaches, therefore, try to reduce the length of the recovery process in different ways and quickly prepare the athlete for the next competition. Among various recovery methods, immersion into water of different temperatures (cold, hot, subsequent cold and hot) is popular among athletes. Cold Water Immersion (CWI) is a popular method of cold therapy that is known as a potential effective anti-inflammatory treatment (Hamedinia et al., 2002).

Many methods have been used to reduce the undesirable effects of dangerous sports activities, although the degree of impact of these interventions is ambiguous. Most importantly, some of these methods may have a negative effect on short-term adaptations resulting from exercise activity. Therefore, in reviewing the recovery process, both aspects of restoration and adaptation should be considered. Therefore, the recovery period should be considered not only as a return to the initial state, but also as a new look at two stages of restoration and short-term adaptation of the training session.Immersion into cold water is one of the methods that have recently become popular in professional sports environments, although this recovering method is used whileits benefits and mechanism are still not scientifically well-known. Today, the use of water immersion among athletes has become prevalent in order to accelerate recovery after exercise (Gayiniet al., 2014).

Typically, the physiological changes occur in the body as the result of cooling. For example, the body temperature slowly returns to its normal level, so that the heart and the circulatory system return to the normal state slowly, and the discharge of acidic products and materials derived from the metabolism ofmuscle cells rapidly occurs. The length and tension of the muscle are quickly returned to the original state, and the time of recovery after exercise is reduced and the internal fluid of the joints can easily be absorbed by tissues.This issue will be of particular importance in preventing damage to the joint and optimized performance.

Therefore, considering the expressed issues and factors as a problem, this study attempts to investigate the muscle damage caused by a soccer-like competition and the result of cold water immersion.

II. Methodology

This study is an applied research in terms of purpose and is a quasi-experiment in terms of data collection method. The statistical population of the present study was football players of Tehran football clubs aged 18 to 29 years old.Twenty male football playerswere selected by a convenient random sampling from Arias sports club of Tehran. The participants volunteered to cooperate with the study. The subjects completed the written consent form and physical health questionnaire. Initially, height, weight, and fat percentage of subjects were measured with stadiometer, digital scale and caliper,respectively. Jackson- Pollack method and three-point method was used to measure fat percentage. Each measurement was performed twice with a 15 second interval between. Then, the maximal aerobic capacity of the subjects was tested using a 12-minute Cooper test and the corresponding equation was calculated.

Pseudo-competitive football protocol

The practice protocol should be similar to football competition, since it is difficult to control the intensity of the practice in a real football match. The pseudo-competitive football protocols include two 45-minute periods of subsequent activity that is simulated withBangsboand the activity pattern of a football match. The profile of the activity of this test is similar to those of professional players, including standing, walking, running with sub maximum speed and running at high speed. Subjects were first dribbled with balls among 10 cones spaced apart at a distance of 5 meters (a) after dribbling a distance of 50 m horizontally, they returned back the same 50-meter path (b), and then traverse the 25-meter-long path with the sub-maxi running (c) and the second 25 m at full speed (d); then, they go the rest of the path slowly to recoverat the starting line (e). The entire route should be passed within 2 minutes. Subjects undergo this route 25 times every halftime. The total distance traveled in this test is 10 km.

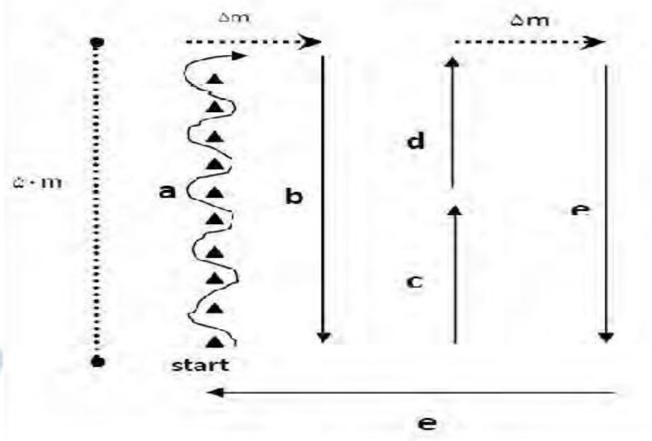

Figure 1
Figure guide:
(a): cone dribbling
(b): rewind running
(c): sub-maxi running
(d): running at maximum speed
(e): walking

Recovery method in water

In this research, for recovery, in cold water, the subjects first performed warm-up exercises for 10 minutes and then placed in a cold water pool at 10 ° C for 10 minutes. The control group did not participate in any water recovery program after carrying out the Bengbao test and 10 minutes of tensile strength.

Sampling blood from the subject

Blood samples were taken from subjects in sitting position and in the rest of the forearm's mandible, at a rate of 5 ml by a laboratory scientist in four stages. First stage blood sampling before the activity, the second stage immediately after the Bangsbotest, the third stage one hour after the Bangsbotest, and after recovery and immersion in cold water, and the fourth stage was implemented 24 hours after the Bangsbotest and immersion in the cold water. Blood samples were first centrifuged at 3000 rpm and plasma was isolated. In order to measure serum creatine kinase (CK), a chemical chlorometric method with an international sensitivity of 1 unit / liter (u / l) was used and the coefficient of change was 1.6%. To measure lactate dehydrogenase (LDH), an enzymatic chlorometric method (DGKC) with a sensitivity of 5 units per liter (u / l) was used and a change coefficient of 1/2% was determined. The kit used is LDH chlorometric kit, manufactured by Pars Test Co., Tehran, Iran.

Measuring functional indicators

A week before the Bangsbotest, the strength and power of the players were measured, and then again, after the immersion in cold water, players were again subjected to the test of power and explosive power. Twenty-four hours after the immersion, the test was again taken to test the power and explosive power of the players. To measure the strength of the players, the strength of the hand paws and manual power gauge (dynamometer) was used and the Sargent vertical jump test was used to measure the explosive power.

Gemmogrov-Smirnov test (k-S) was used to analyze the statistical data to ensure the normal distribution of data. Then, ANOVA with inter-group analysis and Bonferroni post hoc test were used. The significance level of alpha tests is set to 5 hundred. SPSS software version 19 was used to analyze the data.

III. RESULTS

The results of statistical analysis showed that there is a significant difference in the levels of creatine kinase in different stages between the two groups. And the effect size of the independent variable is 0.81. There is also between the measurement steps and the interactive effect group (P = 0.00) and the effect size of the independent variable is 0.39. There was a significant difference between the two groups in the 24-hour period after the pseudo soccer competition and the amount of keratin kinase in the recovery group in cold water was significantly lower than the control group (p = 0.009).

Table 1. Results of the variables under the study

Variable	Group	Before the activity	After the activity	After the recovery	24 hours after the activity
Creatine kinase (unit)	Experimental	Standard deviation ± Mean	Standard deviation ± Mean	Standard deviation ± Mean	Standard deviation ± Mean
	Control	Standard deviation ± Mean	Standard deviation ± Mean	Standard deviation ± Mean	Standard deviation ± Mean
Lactate dehydrogenase (unit)	Experimental	Standard deviation ± Mean	Standard deviation ± Mean	Standard deviation ± Mean	Standard deviation ± Mean
	Control	Standard deviation ± Mean	Standard deviation ± Mean	Standard deviation ± Mean	Standard deviation ± Mean
Sargent jump (cm)	Experimental	Standard deviation ± Mean	Standard deviation ± Mean	Standard deviation ± Mean	Standard deviation ± Mean
	Control	Standard deviation ± Mean	Standard deviation ± Mean	Standard deviation ± Mean	Standard deviation ± Mean
Hand power (kg)	Experimental	Standard deviation ± Mean	Standard deviation ± Mean	Standard deviation ± Mean	Standard deviation ± Mean
	Control	Standard deviation ± Mean	Standard deviation ± Mean	Standard deviation ± Mean	Standard deviation ± Mean

In positive and negative half cycle of the ac voltage the switches of upper and lower bridgeless conv To evaluate the amount of lactate dehydrogenase in two groups of cold water and control group, analysis of variance with intergroup was used. The results of statistical analysis showed that there is a significant difference in the amount of lactate dehydrogenase at different stages (p = 0.000) with the assumption of the lackluster sphincter and by using Green House Householder correction. And the size of the independent variable is 60/0. That is, exercise and recovery activities have affected the levels of lactate dehydrogenase. However, no significant difference was found between the two recovery methods without regard to the measurement steps (p = 0.92). Also, the results of statistical analysis showed that there is a significant difference between the effect of measurement steps and the group (P = 0.002). And the size of the independent variable is 0.25. In other words, there is a significant difference between the patterns of changes in the levels of lactate dehydrogenase in the two groups at different stages of measurement, as in Table 1. It is observed that changes in lactate dehydrogenase in the two cold water groups were different from that of the control group in stage 4. And despite the decrease in the cold water group in the control group, increased.

In order to check the Sargent jump in two groups of cold water and control group, ANOVA with intergroup was used. The results of the statistical analysis showed that there is a significant difference in the amount of jump of Sargent in different stages with the assumption of no clinging of the mousse and using the modified Greenhouse Kaiser test. And the size of the independent variable is 0.53. But there was no significant difference between the two groups (p = 0.278). Also, the results of statistical analysis showed that there is a significant difference between the effect of the stages of measurement and the group (P = 0.039). And the size of the independent variable is 17%. In other words, there is a significant difference between the pattern of changes in the Sargent jump values in the two groups at different stages of measurement, and as in Table 1. It can be seen that changes in the Sargent jump in the cold water group have changed in step 4 compared to the control group.

To assess the strength of hand in two recovery groups in cold water and control group, ANOVA with inter-group factor was used. The results of statistical analysis showed that with the assumption of lackluster crochet and using the modified Greenhouse Kaiser test in power values There is a significant difference between hands at different stages (p = 0.004). And the size of the independent variable is 0.21. In other words, sports and recovery can affect the power of the hand. Also, the results of statistical analysis showed that there is no significant difference between the effect of measurement steps and the group (P = 0.08). There is no significant difference between the pattern of changes in hand strengths in the two groups at different stages of measurement. Table (1)

IV. DISCUSSION

In this study, it was found that 24 hours after the recovery period in the recovery group in cold water, CK and LDH also had a significant decrease compared to the control group. Manshouri et al. (2014) investigated the effects of recovery through cold water immersion on muscle damage and immune system cells. Results showed that immersion in cold water caused a significant decrease in CK compared to control group 1 hour after the activity. Manshouri et al., 2014, and Ascensao et al. 2011 also investigated the effect of 10-minute floatation in cold water at 10 ° C and at 24 hours and 48 hours after a football match, which resulted in faster creatine kinase loss and injury Muscle. Pournot et al. (2011) performed a 15-minute float in water at different temperatures (floating in cold water, hot water and intermittent cold and hot water) after 20 minutes of in-form jump in 26 professional athletes, showing their results This method reduces creatine kinase and muscle damage faster. But in their research, flotation in cold water 24 hours after the activity prevented a significant increase in CK. Therefore, the results of this research are consistent with the results of the researchers mentioned. Pointon& Duffield (2012) in a research entitled "Cold water recovery after simulated sports exercises", the effects of immersion recovery in cold water after simulated sports exercises colliding with collision 10 rugby male athletes participated in three sessions, each of them in 2 30-minute fast paced or tactile speeds, after which they were randomly subjected to immersion in cold water Or passive recovery. The alternate paced exercise included a speed of 15 meters, which was changed every single minute from running mode: fast running first, then walking and walking for 1 minute remaining. Each 6 rounds, the participant went 5 x 10 meters, and received a handle from the shoulder to the lower body. The time of the sprint running and the distance that was run during the sprint running was recorded. Physical symptoms such as voluntary and stimulated muscular function, electromyogram, perceived muscle pain rate, capillary blood flow and hemoglobin for metabolic and muscle damage were measured before and after exercise right after recovery and 2 and 24 hours after recovery. ; The overall area covered during the training was much higher in the absence of the tachymon, without the difference between passive recovery and cold water immersion intervention. Immersion intervention in cold water causes an increase in maximum voluntary muscle contraction, and electromyogram. The amplitude of the wave m after recovery is sharply increased; immersion in cold water has not had any effect on increasing blood parameters for muscle damage. Cold Water Immersion (CWI) is a popular method of curative therapy that has been identified as potentially potent anti-inflammatory intervention (HamediNiao et al., 2002). This method combines hydrostatic pressures of water with a low temperature to reduce the regional metabolism of the body and induces vasoconstriction. Following the high blood pressure of the underlying surface of the brain, it is believed to reduce the need for oxygen in muscle fibers. Therefore, metabolic pressure is reduced (Swenson et al., 1996). This, in turn, makes it less likely that these molecules are absorbed and immune cells are activated and more molecules are released. Cold causes vasoconstriction, which can cause fluid accumulation in muscle fibers. The method of flotation in cold water is more widely used to stimulate vascular contraction after acute musculoskeletal injuries and improve the physiological and psychological recovery and reduce the muscle damage caused by EIMD exercise (Bailey et al., 2007).

In the amount of Sargent jump 24 hours after the recovery period, in the recovery group with cold water, the control group was significant and was not significant in other groups. And the cold water group has a better performance. And also in the hand power of the hand, the type of recovery does not measure the power of the hand at different stages. The results of the research show that even if floating methods in the water return to the original state of the land, physiological variables that lead to fatigue and reduced physical activity do not change significantly, but the feeling of tiredness and muscular tiredness in athletes clearly Decreases. As a result, a faster, more relaxed mental retreat leads to better athletic fitness in the competition. This can help the physical and mental performance of athletes in competitions and exercises. Some researchers have argued that the mental and emotional qualities of recovery can help maintain physical function. Heart rate, blood lactate, creatine kinase, and perceived bruising are indicators that have been used in studies as an initial return factor (Seiler et al., 2007). However, (Rowsell et al. 2009) in a study of footballers reported that after four football matches in four days of floating in cold water, fatigue and muscle aches are reduced. But there is no positive effect on muscle performance, injury and inflammation. It also showed that returning to the original state through buoyancy in the water would maintain the power and ability to jump, but did not have much effect on the subsequent performance of cycling and running. Wilcock et al. (2005) reported a decrease in power after a water flotation method. These differences can be due to different exercise protocols or water floating temperatures. In recent years, it has been reported that heat causes changes in the mechanisms involved in regulating body fluids. Pournot (2011) examined the short-term impacts of various immersions in recovery from intense activity. In this study, the effects of various immersion recovery techniques on the power and maximum power of athletes have been investigated, and the inflammatory response has been evaluated.

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