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The Effect of Two Types of Recovery Activities in Cold Water and Massage on Creatine Kinase (CK) and C-Reactive Protein (CRP) in Football Players

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***Abstract*— the purpose of this study was to compare the effect of two types of recovery (massage and running in cold water) on creatine kinase (CK) and C-reactive protein (CRP) of soccer players following a simulated soccer activity. 14 youth male soccer players were purposefully selected and randomly placed in two groups of recovery of massage and recovery of running in cold water (7 people in each group). On the day of the sports test, at 10:00 AM, all the subjects participated in a simulated soccer physical activity session with the difference that the massage group recovered by massage after the activity; And the cold water running group recovered after the activity by running in cold water. Immediately after the activity, after recovery, 24 hours later and 48 hours after the activity, blood samples were taken from all subjects. The serum levels of CK and CRP first increased and then began to decrease, and these changes were significant (P<0.05), but the difference between the two groups was not significant (P>0.05). Probably, recovery in water or in the form of massage leads to the reduction of inflammation in young football players after a simulated football activity, but there is no difference between the two types of recovery.**

***Keywords*— Recovery in water, delayed onset muscle soreness, massage, soccer, inflammation**

Introduction

The recovery process plays an important role in maintaining sports performance and preventing fatigue for players (1). Athletes are under a lot of pressure, which includes repetition, duration of training and intensity of training, and returning to the initial inappropriate state in intermittent training can cause negative effects on the physical performance of players (2). The pressure of training and competition causes a drop in the athlete's physical performance (3). In addition, it causes continuous and unusual pressures on the athletes' muscles (4, 5). Delayed onset muscle soreness is a reflection of muscle damage in the process of physiological adaptation of muscle to intense training. Among the biochemical signs of delayed muscle contusion is the increase in the level of creatine kinase (CK) in the blood, which increases

when sarcomeres are torn (6). The pain caused by delayed onset muscle soreness usually appears 12 to 24 hours after the activity and may continue for 2 to 5 days (7). Therefore delayed onset muscle soreness can cause the process of returning to the initial state to be slow, and it is even possible that the athlete misses the next training session or sessions. This loss of training sessions can have a negative impact on the football player's preparation process. Also, inflammation plays a role after intense training and delayed onset muscle soreness. Inflammatory factors increase with the start of exercise and gradually accumulate and cause pain in the muscles involved in exercise. One of these factors is C-reactive protein, which starts to increase as soon as the activity is done (8). After intense physical activity, the production of inflammatory cytokines such as TNF-α, interleukin-6 and C-reactive protein increases (9). Coaches and athletes are trying to use appropriate methods to resolve these events, so that recovery is accelerated.

Passive recovery increases cardiac output to a lesser extent compared to active recovery, and less muscle involvement reduces the message received from mechanical receptors and central command (10). Active recovery with low intensity after intense exercise can maintain adrenergic activation and catecholamine concentration (11). Also, during active recovery, muscle glycogen content remains almost constant, but a certain increase is seen in response to passive recovery (12). Consecutive training sessions in a training period cause cumulative adaptive responses. Improper recovery can cause fatigue, reduced adaptation, reduced performance as a result of overexertion or overtraining (13). In this regard, one of the most popular ways to return to the original state is training in water. Changes in water temperature and examination of physiological responses to exercise in hot water, cold water, body temperature water and alternating exercise in hot/cold water can determine the best water temperature limit for returning to the initial state. The difference between these methods is due to the difference in water temperature and different results are obtained at different temperatures (14). Also, nowadays, massage has attracted many customers in the world and is considered as a therapeutic method, and it facilitates recovery after intense training and can be used to increase physical performance. Massage, as a therapeutic and relaxing method, is widely used in sports competitions for the purpose of preparing before the competition, between two competitions and returning to the original state after the competition (15). One of the best benefits of sports massage is its positive effect on sports performance, reducing the time to return to the initial state after activity, reducing muscle tension, reducing lactate, restoring energy reserves through increasing blood flow, nervous excitability, increasing properties muscle elasticity, reduction of delayed onset muscle soreness and finally improved sports performance in the next competition (15, 16). However, there are conflicting results regarding the effectiveness of massage on returning to the desired initial state, in such a way that some studies show that the massage process has no effect on muscle strength and power, heart rate, blood flow, lactate clearance and its excretion, and finally sports performance is (17-21). The results of studies indicate that performing active recovery through keeping muscles active with low intensity reduces blood lactate concentration (15,22), increases or maintains peak and average power (23), facilitates sports performance (24) and reduces heart rate (25). On the other hand, some studies have pointed out the effectiveness of passive recovery on increasing the duration of activity until reaching fatigue (26, 27) and reducing the accumulation of metabolic substances (27) compared to active recovery.

The purpose of this study was to compare the effect of two types of recovery (massage and running in cold water) on creatine kinase (CK) and C-reactive protein (CRP) of soccer players following a simulated soccer activity.

Methodology

This semi-experimental research was conducted with a pre-test and post-test design in two groups including massage recovery and water exercise recovery. The statistical population of the research includes all male football players in the youth age group of Shiraz city. Among them, 14 volunteers were purposefully selected and randomly placed in two recovery groups (massage and running in cold water) (7 people in each group). After the subjects were selected, they appeared in a briefing session a week

before the start of the research, and the purpose of the research and how to implement it were explained to them, and written consent was obtained from them voluntarily. On the day of the sports test, at 10:00 AM, all the subjects participated in a simulated soccer physical activity session with the difference that the massage group recovered by massage after the activity; And the cold water running group recovered after the activity by running in cold water. Immediately after the exercise, after recovery, 24 hours later and 48 hours after the activity, blood samples were taken from all subjects. CK and CRP levels were measured for each sample. This exercise consisted of six 15-minute rounds of special exercises, including walking, dribbling the ball through obstacles, running backwards, running at speed on four straight lines for a distance of 50 meters and back and forth, which was performed on the grass field. Subjects were allowed to drink water after every 15 minutes during a 1.5 minute break. The subjects' heart rate was recorded in the 10th, 20th, 30th and 40th minutes of each half of the exercise. Bishap and colleagues implemented this exercise protocol in 1999. The choice of this protocol is due to the similarity of its stages with the usual techniques of football sports, and the researcher used it with the aim of transferring the real pressure of football training to the subjects (28). Water recovery consisted of walking or running in water with a temperature of 26 to 28 degrees Celsius with a tube for 10 to 15 minutes. The massage protocol also included simple and general massage of large muscles for 30 to 45 minutes. In order to compare and examine the changes of the variables, the statistical test of mixed analysis of variance was used. A significance level of $P \leq 0.05$ was considered. All statistical calculations were done using SPSS version 16 statistical software.

Results

The results of descriptive statistics of the variables are presented in Table 1. The results of the mixed variance analysis test to check and compare the changes of the variables are reported in Table 2. Serum CK levels increased after exercise and then started to decrease, which changes were significant (P=0.001), but the difference between the two groups was not significant (P=0.23). Serum CRP levels increased after exercise and then started to decrease, which changes were significant (P=0.001), but the difference between the two groups was not significant (P=0.15).

Table1. The results related to the mean and standard deviation of the variables

Variables	Groups	After the exercise	After recovery	24 hours later	48 hours later
CK (U/L)	Running in cold water	218.83 ± 27.15	214.91 ± 28.43	206.25 ± 41.17	191.57 ± 37.41
	massage	225.49 ± 29.96	217.64 ± 28.55	198.16 ± 34.38	177.70 ± 26.01
CRP (ng/ml)	Running in cold water	1859.68 ± 290.97	1581.20 ± 276.80	609.92 ± 241.18	340.04 ± 192.73
	massage	1717.74 ± 462.70	1648.23 ± 277.50	541.70 ± 202.22	476.15 ± 211.74

Table2. The results of mixed variance analysis to compare and check the changes of variables

Variables	Factors	F	P	Effect size
CK	Time	24.40	0.001 *	0.88
	group	0.036	0.85	0.003
	Time* group	1.66	0.23	0.33
CRP	Time	44.50	0.001 *	0.93
	group	0.001	0.98	0.001
	Time* group	2.15	0.15	0.39

*significant at the level of $P \leq 0.05$

Discussion

According to the findings of the present study, as a result of recovery in water and massage, the serum levels of CRP and CK decreased significantly after the activity, but there was no significant difference between the two groups. Lira et al. (2015) reported an increase in inflammatory factors after intense upper and lower body intermittent exercise (29). Also, Żebrowska et al. (2015) measured the serum concentration of IL-1β, IL-6 and TNF-α in female athletes, before exercise, immediately after exercise, and 15 minutes after exercise and observed that in 15 minutes After exercise, a significant increase in IL-1β and TNF-α was observed (30). In another research, Donges et al. (2014) investigated the effects of simultaneous resistance and endurance exercises on inflammatory factors. They took blood samples from 8 middle-aged men 1 hour and 4 hours after exercise. IL-1β and TNF-α were significantly increased at 1 h post-exercise, although they returned to resting levels by 4 h post-exercise (31). According to the available scientific findings, it seems that after eccentric activities that are associated with muscle contusion, the increase of inflammatory factors is also higher. In this regard, Yamanishi et al. (2014) investigated the effect of concentric and eccentric resistance training on inflammatory factors. 20 healthy adults did both exercise sessions. 24 hours after exercise, the variables were evaluated. The results showed that TNF-α levels increased significantly after eccentric exercise compared to concentric exercise. Therefore, they concluded that due to more metabolic stress, inflammatory factors increase after eccentric exercise more than concentric exercise (32).

One of the main reasons for using active recovery compared to passive recovery after intense training is that active recovery increases lactate removal compared to passive recovery (33,34). According to Declan et al. (2003), although serum lactate concentrations are similar during active and passive recovery, increased blood flow during active recovery may decrease intracellular lactate without affecting serum lactate (35). Higgins et al. (2013) investigated the effect of three methods of floating in cold water, contrasting water shower and passive recovery on the perception of contusion. The results indicate that the contrasting water shower method, compared to the other two recovery methods, caused a significant increase in the perception of muscle stiffness one hour after training (36). Sayers et al. (2011) investigated the effect of three methods of passive recovery, active and floating in opposite water on the delayed onset muscle soreness of 16 hockey players after the Wingate test (37). The results showed that the degree of soreness was significantly reduced after the method of floating in contrasting water and active recovery compared to passive recovery, but no significant difference was observed between the two methods of floating and active recovery. Based on the previous results, the use of different periods of floating in hot and cold water gives different results. The best effect of buoyancy in contrasting water is seen in times longer than 12 minutes (38). Pournot et al. (2011) investigated the effect of recovery methods of buoyancy in hot water, cold water, contrasting water and returning to the initial passive state after an intermittent and tiring exercise on the perception of muscle soreness. The findings of this research stated that the two methods of floating in cold water and opposite to the other two methods, returning to the initial state, lead to a reduction in the perception of muscle stiffness after the exercise (39). Elias et al. (2013) compared three methods of returning to the initial state on the soreness levels of futsal players after training. The results showed that two methods of floating in water cause a significant reduction in the perception of muscle soreness compared to passive recovery (40). In addition, Ingram et al. (2009) reported that floating in contrasting water leads to a lower perception of muscle soreness than passive recovery (41). Rezaei et al. (2012) compared the effect of different temperatures of floating in water on the physical performance of swimmers. The results showed a significant difference between the methods of floating in opposite water and cold water and the passive method (42). On the other hand, the research results of Crowe et al. (2007) show the drop in the second performance of the Wingate test after 15 minutes of floating in cold water. They have suggested that floating in warm water with an hour between speed trainings has a better effect on the next performance due to the increase in the range of motion of the muscles (43). Although many studies have shown that different methods of returning to the initial state are effective in lactate excretion, but in relation to the subsequent performance, the results are contradictory and show that factors such as creatine kinase levels, C-reactive protein, heart rate and Temperature etc. have an effect on anaerobic functions (44, 45). During intense activity, due to the increase in peripheral blood pressure, blood fluids leave the capillaries and enter the active muscles.

Accelerating the return of fluids to the blood stream, in addition to increasing movement and elimination of metabolic waste products, reduces muscle pain and stiffness and improves performance (44, 45).
Professional football players do intense training during the week to prepare for the competition and hold an official competition on the weekend. These trainings and competitions continue during the season. Also, players may play two or three games a week in Asian and world tournaments. All these factors lead to high physical pressure on the players and lower performance of the athletes. The results of Hemmings et al.'s (2000) research on the effects of massage on some physiological, psychological and performance indices of boxers showed that the psychological aspect of massage effects is more obvious than its physiological and performance aspects (46). This inconsistency in the findings is probably due to the difference in the protocols. According to research reports, it is believed that one of the most important advantages of sports massage, especially during sports competitions, and as a result of improving performance in the next competition, is overcoming fatigue and reducing recovery time. Although many elite athletes believe that massage is an important part of their success, the effects of massage itself remain in question. Massage can improve some physiological symptoms, but some studies have not shown any effect on recovery parameters (47-49). According to research findings, massage has many physiological and psychological benefits that may play a significant role in pain relief and tissue regeneration by increasing blood circulation and coagulation flow (50). Due to its unique applications, this intervention is a method that is used in many fields such as therapy, rehabilitation, and recovery from injuries or sports (50).

Conclusion

Probably, recovery in water or in the form of massage leads to the reduction of inflammation in young football players after a simulated football activity, but there is no difference between the two types of recovery.

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