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RESEARCH ARTICLE

Comparison of effects of active recovery and deep water running on soccer players' indices of muscular damage

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ABSTRACT

Background: The process of recovery plays a significant role in sustaining athletic performance and preventing exhaustion among players. Active recovery (AR) is generally accepted as a series of light intrinsic activity after intense activities. It is believed that this type of recovery improves athletes' recovery process. On the other hand, among different recovery methods, recovery in water in different temperatures is highly reputed among athletes. **Aims and Objectives:** The present research was aimed at comparison of effects of AR and deep water running (DWR) on serum levels of creatine kinase (CK), lactate dehydrogenase (LDH), and aspartate aminotransferases (AST) as indices of muscular damage subsequent to a simulated soccer game among 19-21-year-old players of Ahwaz Naft soccer team present in premier league. **Materials and Methods:** 18 players of Naft soccer team were randomly assigned to either of the two 9 membered groups of AR and DWR. Afterward, the aforementioned participants took part in a 90 min (including two 45 min rounds of random activity) simulated soccer activity that was primarily designed by Bangsbow and modified by Bishop et al. After the activity, one group was administered an AR while the other was administered DWR recovery. To compare the changes of variables in the aforementioned groups, the statistical method of mixed variance analysis among individuals was used. **Results:** The difference between changes of variables between the groups of AR and DWR was not statistically significant ($P = 0.541$, $P = 115$ and $P = 748$, respectively, for LDH, CK, and AST). **Conclusion:** It seems that there is no statistically significant difference between the effects of AR and DWR recovery on muscular damages of soccer players after a period of playing. However, still more research is required in this regard.

KEY WORDS: Football; Recovery; Muscular Bruising; Creatine Kinase; Recovery in Water

INTRODUCTION

During their training programs, and especially in periods before tournaments, soccer players do exercises with maximal intensity, and in addition, they are also subjected to exhausting schedules during tournament seasons. On this basis, improper recovery subsequent to pressures of exercise and playing can lead to deterioration of players' physical performance[1,2] resulting in the projection of extraordinary and continued stress on their muscles[3,4] One condition that may resultantly occur is muscle soreness which results in discomfort, pain, and reduced physical performance. The pain due to delayed muscle soreness normally emerges between 12 and 24 h after the activity and may remain for 2-5 days.[5] One of the mechanical elements of soreness may lie in damaging of sarcomeres in a muscular structure which ultimately result in tearing of Z plates.[6] Among the biochemical symptoms of delayed muscle soreness, it can be referred to an increase in levels of creatine kinase enzyme (CK),

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with its serum levels increasing concurrent with tearing of sarcomeres.[7] In addition, intense exercise is usually accompanied by an increase in the level of lactate dehydrogenase enzyme (LDH) enzyme.[8] On the other hand, aspartate aminotransferase (AST) has been frequently considered as an indicator of muscular damage in various studies.[9] In general, the muscular damage is associated with the release of AST, creatine phosphokinase, and LDH enzymes.[10] In other words, increased levels of CK, LDH, and AST after intense exercise may result in an increase in the concentration of enzymes indicating muscular damage as well as the occurrence of oxidative stress.[11,12]

As a result of the influence of the phenomenon of muscle soreness and oxidative stress on physical performance and wellness status, both coaches and athletes seek suitable methods for overcoming this phenomenon. The process of recovery plays a significant role in sustaining athletic performance and preventing exhaustion among players.[13] In this regard, active recovery (AR) is generally accepted as a series of light intrinsic activity after intense activities. It is believed that this type of recovery improves athletes' recovery process.[14] Compared the passive recovery, AR increases the intake of lactate.[15,16] Low-intensity AR after exercises with high intensity can result in activation of androgenic alopecia and increased catecholamine concentration.[17] On the other hand, among different recovery methods, recovery in water in different temperatures is highly reputed among athletes. Although that there are contradictory information in this context, but generally, the method of recovery in water is widely applied for making vascular contraction after the occurrence of severe muscular damages as well as the progression of physiological and psychological recovery and reduction of muscular damages resulting from sports.[18] As reported by some researchers, recovery in cold, warm, and mixture of hot and cold waters results in the increased pace of removal of CK from blood and also a contraction of vessels resulting from recovering in cold water reduces the amount of pain and inflammation. In addition, this method decreases cellular necrosis, neutrophils' immigration, cellular metabolism, and pace of guidance of neural messages which resultantly results in a reduction of damages.[19] Roswell et al.[20], performed a study in soccer players and reported that after playing four soccer matches in 4 days, cold water recovery resulted in a reduction of exhaustion and muscular pain, but it does not have any significant effects on performance, damages, and muscular inflammation.

Since there were no prior studies having elaborated on comparison of effects of two types of recovery, namely, as AR and deep water running (DWR) among soccer players and considering the fact that soccer is the most popular sport in the world and that improvement of soccer players is highly important; the present study was aimed at comparison of effects of AR and DWR on serum levels of CK, LDH, and AST as indices of muscular damage subsequent to a period of simulated soccer activity among 19-21-year-old players of Ahwaz Naft team present in premier league.

MATERIALS AND METHODS

This research is a semi-experimental study with a pre-test-post-test design. A number of 18 players of Ahwaz Naft soccer team employed in the premier league with a body mass index (BMI) of between 19 and 24 KGs per square meter were selected as the participants of the study. Afterward, these 18 players have been assigned to either of the two 9 member groups of AR and DWR. After selecting the individuals, they were asked to follow the researcher's proposed program for 2 weeks. They were obliged to eat three normal daily meals between the hours of 7:30 and 8:30; 13-14 and 21-22. This was administered to homogenize participants in terms of sleeping and waking hours and times of eating food. Furthermore, the participants were recommended to eat only normal routine foods and avoid taking in any kind of supplement and or medication. They were, nevertheless, asked to wake up between 7:30 and 8:30 and go to sleep at between 11 and 12 p.m. Nevertheless, 48 h before execution of the proposed sporting protocol, participants made a presence in Fajr Hotel of Ahwaz to be able to control their nutrition and sleeping cycles.[21] For this reason, necessary arrangements were made with the management of the Fajr Hotel for continued residence of participants and supplication of their meals. On the other hand, it should be mentioned that the sporting facility and swimming pool of Naft complex of Ahwaz were used for execution of proposed sporting protocol. In addition, further arrangements were made with the sampling unit and laboratory unit of Shahid Tondgooyan hospital to have a sampler, centrifuge, and freezer for the storage of samples. A week before execution of the proposed protocol, the individuals were asked to make a presence at sporting facility of Naft complex, and after clarification of the goal and details of research, they were asked to fill in written consent forms. Afterward, individuals' height and weight were respectively measured with a height measurement device, and Germany made scale. In addition, BMI was calculated through dividing the square of height (meters) by weight (kilograms). On the day of execution of proposed sporting protocol, individuals of the both groups took part in a 90 min (two 45 min rounds) simulated soccer activity that was primarily developed by Bangsbow (1991) and later reformed by Bishop et al. The silhouette of this activity is similar to activities performed by professional soccer players including standing, walking, nonmaximal intensity running, and maximal intensity running. This protocol includes two rounds each including 45 min of activity with a 15 min resting interval between each round. Each 45 min round is divided into smaller sections. These sections include 7 periods of 2 min activity including 50 m of ball dribbling between cones that are 5 m away from each other, 50 m of running backward, and 50 m of walking. The remaining

time at the end of each 2 min section is considered as resting time. The total distance travelled during the whole 90 min of this test is approximately 10 km which is similar to the distances reported players of English Premier League.[22] After execution of the simulated soccer activity, one group was administered a recovery in deep water while the other group was administered an AR. The AR included 8 min of activity on dry land comprising of 8 min of juggling, 8 min of walking and back and forth running, and 4 min of tensile movements.[23,24] On the other hand, DWR included 10 min of walking and tensile movements, 30 min of walking and running in deep water, and 5 min of cooling down with more tensile movements.[25] 5 ml of individuals' blood was extracted from their arm vessel before activity, immediately after the activity, 24 h after the activity, and 48 h and 72 h after the activity. To separate the serums, the blood samples were centrifuged for 10 min at the speed of 2000 RPMs after clotting. Until the time of measurement of variables, the samples were kept in a fridge at -20°C. Serum levels of CK, LDH, and AST were measured for each sample using the colorimetric method and Germany made ROSCH device. In terms of statistical analyses, research data were first subjected to descriptive statistics, and in this regard, the data were described according to standard deviations. Afterward, the normality of data distribution was checked using the Shapiro-Wilk test, and it was further manifested that data were normally distributed. On this basis, the mixed variance analysis method was used for comparison of changes in variables in two groups of AR and DWR through repetitive measurement in a 2 × 5 design.

RESULTS

The mean and standard deviation values of the aforementioned two groups were measured at five different times, and results are shown in Table 1. In addition, Table 2 includes the results of mixed variance analysis between the individuals of the two groups.

Results have shown that the changes were statistically insignificant in all three variables of muscular damage indices between the two groups of AR and DWR ($P = 0.541$, $P = 115$ and $P = 748$, respectively, for CK, LDH, and AST).

DISCUSSION

The present study tried to compare the effects of AR and running in deep water subsequent to a period of simulated soccer activity on indices of muscular damage among soccer players. Results have shown that differences between changes in serum levels of CK, LDH, and AST were not significant between the AR and DWR groups. Considering, the fact that the muscular damage indices had not significantly changed in none of the groups, it can be said that probably both types of recovery have beneficial effects on reduction of muscular damages subsequent to exercises and matches in a soccer game. Although that there may not be a statistically significant difference between the effects of these two types of recovery, still if the present study had also included a control group, we could have made more certain comments regarding the differential effects of the former and latter types of recovery. Soccer is a sport in which different physiological systems including the skeletal-muscular, the nervous, the immune, and metabolism systems are involved. On this basis, making use of effective strategies regarding recovery until the next game is of high importance. Intense exercises and soccer games have been shown to weaken the immune system and cause metabolic disorders.[21] Therefore, when soccer games are held with high intensity, it becomes more important to find suitable recovery methods.[21] In this regard, results obtained by Watts et al. (2000) and Nikros (2007) show that AR has beneficial effects on indices of muscular damage.[26,27] They have shown that recovering back to the initial status is effective in terms of faster removal of lactate. CK, lactate, and AST are among the assuring indices of permeability of the muscle membrane[28] because this enzyme is only found in heart and skeletal muscles. On this basis, deterioration of Z lines and damaging the sarcolemma makes the infusion of enzymes of muscle such as CK into the intertissue water possible.[29] Muscular tissues may be damaged due to metabolic, mechanical, and or a mixture of both elements subsequent to intense exercises or games. Serum levels of enzymes and proteins of skeletal muscles are considered as symptoms of the status of performance of muscular tissues and are highly different in every pathologic and or physiological condition. CK and LDH-DHT are the most applied serum symptoms of muscular damages which may change after intense physical activity.[30] During intense

Table 1: Mean and SD values of studied variables

Variable	Group	Before activity	Immediately after activity	24 h after activity (am)	48 h after activity (am)	72 h after activity (am)
LDH (mg/l)	DWR	5.371±0.524	5.468±0.458	5.418±0.767	5.366±0.488	0.292±5.449
	AR	4.377±0.460	4.529±0.272	4.519±0.614	4.517±0.488	0.498±4.558
CK (mg/l)	DWR	3.277±0.421	3.294±0.287	3.316±0.383	3.479±0.246	0.407±3.498
	AR	4.951±0.753	5±0.412	5.041±0.524	5.417±0.320	0.544±0.540
AST (mg/l)	DWR	2.673±0.389	2.771±0.332	2.932±0.395	3.116±0.331	0.186±3.123
	AR	1.210±0.238	1.262±0.193	1.547±0.189	1.449±0.197	0.258±0.564

LDH: Lactate dehydrogenase, DWR: Deep water running, CK: Creatine kinase, AR: Active recovery, SD: Standard deviation

Table 2: Results of mixed variance analysis

Variable	F-test	*P* value	Effect size
LDH	0.782	0.541	0.047
CK	2.232	0.115	0.122
AST	0.484	0.748	0.029

LDH: Lactate dehydrogenase, CK: Creatine kinase, AST: Aspartate aminotransferases

activities, as a result of increased blood pressure, the fluids of the blood exceed the capillaries and enter active muscles.

On the other hand, it has been reported that recovery in deep water can be a suitable substitution for regular recover methods in days after tournaments.[21] Reilly et al.,[31] have also reported that running in deep water results in decreased muscular pain. Pournot et al. investigated the effects of recovery methods after a continuous and exhausting exercise on anaerobic performance 24 h after the recovery period. They concluded that after exercising, the anaerobic performance of the group floating in the water was highly improved compared to 1 h before and after exercising.[32] In general, water has physical characteristics different than air and may reflect different physiological responses in a way that body's heat transfer ability improves in water.[33,34] This issue may result in more desirable recovery in water environment compared to air. In addition, running in deep water can result in a reduction of stress on skeletal muscles which ultimately results in reduced muscular damages.[35] While floating, the pressure imposed by the water results in movements of fluids from the external-cellular spaces toward the inside of vessels, and therefore, more blood is pumped into the muscles, and resultantly, the body's overall vascular return, heart output, and blood flow are increased. In addition, acceleration of return of fluids to blood flow not only results in faster disposal of wastes produced by body metabolism but also results in the reduction of muscular pain and soreness and improves performance as well.[36,37] However, the findings of the present study have not shown any statistically significant difference between these types of recovery. Increasing the sample size in a future study can yield more generalizable and precise results. However, a suitable recovery after exercising is dependent on various aspects including personal differences and lifestyles of individuals.[21]

During the week, soccer players undertake intense exercises, and at the end of the week, they will hold an official match. These exercises and matches are continued during the whole season. In addition, in global or continental tournaments, players may have to attend three to four matches per week. All these results in the exposure of athletes' bodies to severe stresses and resultantly, their further or next performance would be deteriorated. It is recommended to do more studies containing larger sample sizes in addition to considering for a control group as well and while also measuring other variables related to tissue damages, especially inflammatory elements and indices of oxidative stresses to be able to have a better understanding of finding better desirable recovery methods among soccer players.

CONCLUSION

It seems that there are no statistically significant differences between the effects of AR and recovery by running in deep water on muscular damages of soccer players subsequent to a period of activity. However, we still require more research and larger study samples, in addition, controlling for more variables of muscle soreness including pain and range of motion as well as inflammatory indices and oxidative stresses.

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