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The Effect of Two Different Recovery Methods on Muscle Damage

Farklı Iki Toparlanma Yönteminin Kas Hasarına Etkisi

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ABSTRACT

This study was conducted to investigate the effect of two different recovery methods on recovery after high-intensity training. 20 male amateur football players between the ages of 18-26 participated in the research. Creatine kinase (CK) and Alanine aminotransferase (ALT) blood samples were taken from the athletes under resting conditions before the muscle damage exercise protocol (EE). Cold water protocol was applied to the experimental groups, respectively, and 10 days after the end of this protocol, the hot water protocol was applied. It was determined that there were no significant differences for the ALT variable between the measurement values of hot water and cold-water application ($p>0.05$). It was determined that there was no significant difference at the $p<0.05$ level for the CK variable between the measurement values of hot water and cold-water application ($p>0.05$). As a result, in the literature reviews, it was determined that skeletal muscle damage occurred in athletes after high-intensity exercise and competitions. It has been concluded that hot water application is a more effective method than cold water application in tolerating the damage.

Keywords: Cold water immersion, Muscle damage, Recovery, Hot water.

ÖZET

Bu çalışma yüksek yoğunlukta yapılan antrenmanlardan sonra Farklı iki toparlanma yönteminin toparlanma üzerine etkisini araştırmak amacı ile yapılmıştır. Araştırmaya 18-26 yaş aralığın da 20 erkek amatör futbol oyuncusu katılmıştır. Sporculardan kas hasarı egzersiz protokolünden önce (EÖ) dinlenik şartlarda Kreatin kinaz (CK) ve Alanin aminotransferaz (ALT) kan örnekleri alınmıştır. Deney gruplarına sırasıyla önce soğuk su protokolü uygulanmış, bu protokolün bitmesinden 10 gün sonra ise sıcak su protokolü uygulanmıştır. Burada, aynı sporcular üzerinde iki farklı toparlamanın kas hasarına etkilerinin araştırılması amaçlanmıştır. Sıcak su ve soğuk su uygulaması ölçüm değerleri arasında ALT değişkeni için anlamlı farklılıklar olmadığı belirlenmiştir ($p>0,05$). Sıcak su ve soğuk su uygulaması ölçüm değerleri arasında CK değişkeni için $p<0,05$ düzeyinde anlamlı farklılıklar olmadığı belirlenmiştir ($p>0,05$). Sonuç olarak; Yapılan literatür incelemelerinde yüksek yoğunluklu egzersiz ve müsabakalardan sonra sporcularda belirgin bir şekilde iskelet kas hasarı oluştuğu tespit edilmiştir. Oluşan hasarın tolere edilmesinde sıcak su uygulamasının soğuk su uygulamasına göre daha etkili yöntem olduğu sonucu elde edilmiştir.

Anahtar Kelimeler: Soğuk su immersiyonu, Kas hasarı, Toparlanma, Sıcak su.

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INTRODUCTION

Fatigue is defined as the temporary decrease in the performance of the muscles, the deterioration of their ability to respond to stimuli, and their inability to produce or maintain power (Akgün, 1993). In other words, fatigue is defined as the decrease in the expected power or power output from the muscles (Allen at all., 1995). Fatigue is a complex concept that includes both psychological and various physiological factors (Canli at all., 2018). There are different definitions of fatigue in the literature. These different definitions of fatigue stem from the disciplines' interpretation of fatigue by their own sciences. For example, psychologists have expressed the feeling of burnout, biomechanics have expressed it as decreased force output, and physiologists have expressed it in different ways such as suppression in the physiological system. In fact, all disciplines agree on the point that fatigue is the strength or power decreases. Forcing the organism while training increases the development and thus the success. It cannot be said that the trainings that are done without forcing the body too much have a great effect after a certain point. For this reason, since compulsive training is essential for development, professional athletes also do compulsive training at least once a day (Krustrup at all., 2005). These exercises cause serious physiological and psychological fatigue. It is very important to remove or minimize the causes of fatigue. The athlete's going to the next competition or training without recovery will affect the performance (Alemdaroğlu, 2011).

The process required for the body to return to its pre-exercise state after exercise, or in other words, as long as the body is regenerated both psychologically and physiologically, is called recovery (Kellmann at all., 2018). The body enters the process of renewing itself after the exercise and tries to repair the destruction caused by the load. Naturally, psychological, physiological and biochemical changes are inevitable throughout the process. The organism consumes high oxygen by consuming energy for a while even after training. This consuming helps recovery after training (Sargin, & Selçuk, 2018).

Ensuring this balance of loading and recovery is very important in the success of the athlete. The performance of the athletes who cannot recover sufficiently after loading decreases in the next loading (Russell at all.,2019). In this situation, it is vital to make recovery more effective. Therefore, many recovery strategies have been developed. The effectiveness of these strategies is discussed by sports scientists, and their advantages and disadvantages are investigated (Andersson at all., 2008). It is known that intense competition programs, trainings and competitions cause a high degree of fatigue in athletes. In this study, it was aimed to investigate the effect of the cold-water protocol applied after high-intensity exercises, and the hot water protocol 10 days after the end of this protocol, on the recovery time.

METHOD

Population and Sample of the Research: 20 male amateur football players between the ages of 18-26 with an average of 5 years of experience participated in the study. Athletes who had not trained during the week before the start of the study were divided into two groups, 10 experimental and 10 control. The group of athletes were informed about the study and were asked to fill out a form stating that they voluntarily participated in the study.

Design of the Study: The research is planned in two parts. Athletes were divided into two groups of 10 as control and experimental groups. Cold water protocol was applied to the experimental groups, respectively, and 10 days after the end of this protocol, the hot water protocol was applied. Here, it is aimed to investigate the effects of two different recovery exercises on the same athletes on muscle damage.

For the cold-water protocol, blood samples were taken from the experimental group participating in the study under resting conditions just before the muscle damage protocol. Immediately after the muscle damage protocol, the subject group was immersed in water at 13.5 ^{o}C for 10 minutes, keeping the neck and shoulders out. 2 and 24 hours after the cold-water application, CK and ALT blood samples were taken from the experimental group again and analyzed. The control group participated in all measurements except cold water application. For the hot water protocol, the temperature of the water was set as 35^{o}C and all the methods applied in cold water were repeated (Takeda at al., 2014; Wahyuni at al., 2019).

Muscle Damage Training Protocol: The muscle damage exercise protocol consisted of a depth jump from a height of 60 cm. Jumps were performed in 5 sets, with 20 repetitions, with a 10-second interval, and a 2 minute rest period was given between sets. The athletes who performed the jumps from a height of 60 cm were asked to jump as high as possible from 90 degrees of flexion as soon as they touched the ground. This protocol has been successfully applied in previous studies (Goodall & Howatson, 2008; Kirby at all., 2012; Kocaağa, 2014).

Data Collection Process: The height and body weight of the athletes were measured for body composition (Sarıkaya et al., 2023). Bioelectric Impedance was used to determine the body fat percentage of the athletes (Tanita Body Fat Analyser, Model TBF 300).

Biochemical Analysis: In order to evaluate the results of the subjects regarding biochemical variables, 5 ml venous blood samples were taken from their antecubital veins before and after cold water and hot water application. Blood samples were taken by a doctor in a private hospital.

Statistical Analysis: The arithmetic mean and standard deviations [ss] of all data were calculated for descriptive statistics. Two-way analysis of variance test was used in repeated measurements to compare the CK and ALT changes of the groups. Data analysis was done in SPSS 18 package program. Analyzes were carried out by assuming the significance level of p<0.05 in all statistical procedures.

Ethics Committee Approval: To conduct the research, approval was obtained from the Non-Interventional Clinical Research Ethics Committee of Van Yüzüncü Yıl University (Date: April 16, 2021, Decision No: 2021/05-16), confirming that the implementation of this study is in accordance with ethical guidelines.

RESULTS

Table 1. Descriptive Data of Control and Experimental Group

	Group	n	Minimum	Maksimum	$\bar{x}$	ss
Age (years)	Experiment	10	18,00	26,00	21,00	75,43
	Control	10	19,00	26,00	23,27	86,63
Length (cm)	Experiment	10	163,00	177,00	173,25	125,04
	Control	10	164,00	178,00	172,24	150,86
Body Weight (kg)	Experiment	10	67,00	79,00	73,87	600,93
	Control	10	60,00	76,50	69,88	714,61
Body Mass Index (kg/m2)	Experiment	10	19,78	22,42	21,46	21,65
	Control	10	17,49	23,36	21,05	22,80

Note: ss= Sum of Squares

Table 2. Comparison of ALT (U/L) Level Differences of Experimental Groups

<table>
<tr><th rowspan="2">Group</th><th rowspan="2">n</th><th>Pre-Test</th><th>Mid-Test</th><th>Post-Test</th><th colspan="2">Measurement*Group</th></tr>
<tr><th>$\bar{x}$±Sd.</th><th>$\bar{x}$±Sd.</th><th>$\bar{x}$±Sd.</th><th>F</th><th>p</th></tr>
<tr><td>Hot Water Application</td><td>10</td><td>28,87±18,71</td><td>19,75±16,67</td><td>29,12±15,91</td><td rowspan="2">2,221</td><td rowspan="2">0,855</td></tr>
<tr><td>Cold water Application</td><td>10</td><td>23,37±8,58</td><td>22,37±8,73</td><td>22,25±8,69</td></tr>
<tr><td>Between Groups</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>z</td><td></td><td>2,133</td><td>3,185</td><td>1,168</td><td></td><td></td></tr>
<tr><td>p</td><td></td><td>0,041*</td><td>0,058</td><td>0,936</td><td></td><td></td></tr>
</table>

**p<0.05, $\bar{x}$: Mean, Ss.: Standard Deviation.*

It was determined that there was no statistically significant difference at the p<0.05 level for the ALT variable between the measurement values of cold water and hot water application (p>0.05). For the ALT variable, a significant difference was found between the hot water application and **c**old-water application experimental groups for the pre-test values (p<0.05). No significant difference was found for the mid-test and post-test values (p>0.05).

Table 3. Comparison of ALT (U/L) Level Differences of Control Groups

Group	n	Pre-Test $\bar{x}$±Sd.	Mid-Test $\bar{x}$±Sd.	Post-Test $\bar{x}$±Sd.	Measurement*Group F	p
ALT (U/L) First Measurement (First Day)	10	28,21±3,85	32,15±4,25	27,45±6,26	2,244	0,069
ALT (U/L) Second Measurement (Tenth Day)	10	27,45±5,25	29,15±4,82	28,45±2,58		
Gruplar Arası						
z		-1,440	2,658	1,620		
p		0,028*	0,046*	0,034*		

**p<0.05, $\bar{x}$: Mean, Ss.: Standard Deviation.*

No statistically significant difference was observed in the comparison of the pre-, mid and post-tests of the athletes participating in the study (p>0.05). When the findings of ALT levels between the groups of the First and Second Measurement protocols were examined, it was found that there was a statistically significant difference between the pre-test and mid test averages after the second measurement (p<0.05), but The second measurement was found to have a statistically significant difference compared to the first measurement (p<0.05).

Table 4. Comparison of CK (U/L) Level Differences of Experimental Groups

Group	n	Pre-Test $\bar{x}$±Ss.	Mid-Test $\bar{x}$±Sd.	Post-Test $\bar{x}$±Sd.	Measurement*Group F	p
Hot water application (first day)	*10*	189,86±76,64	236,61±65,69	314,31±79,77	2,121	0,056
Cold Water Application (Tenth day)	10	181,36±57,51	218,58±76,70	277,13±51,33		
Between Groups						
z		1,628	2,215	2,057		
p		0,007*	0,017*	0,065		

**p<0.05, $\bar{x}$: Mean, Ss.: Standard Deviation.*

It was determined that there was no significant difference at the p<0.05 level for the CK variable between the measurement values of hot water and cold-water application (p>0.05**).** For the CK variable, a significant difference was found between the cold water and hot water application experimental groups for the pre-test and mid-test values (p<0.05). No significant difference was found for post-test values (p>0.05).

Table 5. Comparison of CK (U/L) Level Differences of Control Groups

Group	n	Pre-Test $\bar{x}$±Sd.	Mid-Test $\bar{x}$±Sd.	Post-Test $\bar{x}$±Sd.	Measurement*Group F	p
CK (U/L) First Measurement (First Day)	10	191,52±67,60	257.58±91,21	407,19±60,80	1,486	0,058
CK (U/L) Second Measurement (Tenth	10	194,60±70,28	260,35±90,21	401,41±74,21		
Gruplar Arası						
z		1,325	1,986	-1,865		
p		0,049*	0,055*	0,068		

**p<0.05, $\bar{x}$: Mean, Ss.: Standard Deviation.*

No statistically significant difference was observed in the comparison of the pre-, mid and post-test of the athletes participating in the study (p>0.05), but in the comparison between the groups, it was determined that there was a statistically significant difference between the pre-test and mid-test averages of the Second Measurement protocol compared to the First Measurement protocol (p<0.05).

DISCUSSION and CONCLUSION

Two different recovery methods, cold water and hot water, were applied to 20 male amateur football players between the ages of 18-26 after high-intensity exercise and the effects of these methods on muscle damage were investigated.

When the studies on muscle damage were examined, it was determined that muscle damage occurred in athletes after many different loading methods applied. Among these training methods, it has been explained in the literature that one of the most effective training types that cause muscle damage is the method that includes eccentric muscle contractions. (Proske & Allen 2006; Banfi at all., 2010; Hikida at all., 1983; Warhol, 1985; Lauritzen, 2009; Warren at all., 2001; Corona at all., 2010; Burt & Twist, 2011; Philippou at all., 2009; Ascensão at all., 2008).

Creatine kinase, Lactate dehydrogenase, Aspartate aminotransferase, Myoglobin, Alanine aminotransferase and Myosin serum levels are the most frequently measured in the observation of damage by looking at the serum levels of muscle enzyme proteins. These are enzymes that increase in signs of skeletal muscle damage from a few hours to a few days, depending on the type of exercise (Nosaka at all., 1992).

As a result of the muscle damage exercise protocol applied in this study, the blood values taken from the athletes were followed and as a result of the applied protocol, it was observed that the serum levels of the muscle enzyme proteins of the athletes increased.

There are other studies in which ALT, AST, LDH, and CK levels, which are markers of muscle damage, reached their maximum value between 4-6 hours after exercise and 24 hours, and returned to normal within a maximum of 48 hours (Clarkson at all., 2006; Banfi at all., 2010).

In a study conducted with 16 volleyball players aged 20-30 years in which the effects of cold-water application on muscle damage were examined, it was determined that AST, ALT and LDH values of both the experimental group and control groups were within the reference (limit) ranges specified for the relevant enzymes, while the CK value exceeded the reference limit. (Balık, 2021).

For the ALT variable, a significant difference was found between the hot water and cold-water application experimental groups for the pre-test values ($p<0.05$). For the CK variable, a significant difference was found between the cold water and hot water application experimental groups for the pre-test and mid test values ($p<0.05$).

In a study, the performance values of 19 badminton athletes between the ages of 21-27 were investigated after cold water application. In the measurements after 24 hours, the cold water applied experimental group was found to have lower AST, ALT and CK levels than the control group and was more successful in performance tests (Çakır, 2017).

In another study, 40 male athletes between the ages of 19-23 were carried out with the voluntary participation. Immersed in cold water (n:10- 10°-15min.), hot water immersion (n:10- 38°-15min.), active (n:10 -15 min. jog) and passive recovery (n:10 - 15 min. passive rest) methods were applied to athletes. As a result, the cold-water immersion protocol was found to be the most effective method in preventing muscle damage compared to other protocols (Çelebi, 2018).

In another study in which cold water application had a positive effect, massage, hot water therapy and cold-water application were applied to three groups of ten senior rugby players. As a result, it was reported that the total serum creatine kinase (CK) concentration decreased in the cold-water treatment group compared to the other groups (Banfi at all., 2007).

Pournot (2011) applied an intense training program consisting of jumping rope and vertical jumping for 20 minutes to 41 elite male athletes consisting of football, rugby and volleyball players. Afterwards, the athletes divided into four groups were applied hot water at 36°C, cold water at 10°C, contrast water therapy at 10-42°C, and passive rest. After these applications, enzymes, which are indicators of muscle damage, were followed up to 1 and 24 hours, and as a result, it was determined that cold water application and contrast water therapy were quite effective in rapid recovery in practice (Pournot at all., 2011).

When the effect of passive, active and contrast water bath application on recovery was investigated, it was determined that the most effective method was contrast water (Coffey at all., 2004).

As a result, in the literature reviews, it was determined that skeletal muscle damage occurred in athletes after high-intensity exercise and competitions. It has been concluded that cold water application is a more effective method than hot water application in tolerating the damage. When the performance of the groups was examined, less muscle damage and therefore more performance development was achieved with cold water application compared to the other groups. When the performance of the groups from the pre-test to the post-test was compared statistically, it was seen that the cold-water application had a more positive change compared to the other groups.

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