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Effect of Maximal Anaerobic Loading on Lower Extremity Proprioceptive Sense in Soccer Players

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Abstract

This study was carried out to determine the effect of lower extremity muscle fatigue on proprioceptive sense in soccer players. 26 male soccer players who play licensed soccer in the amateur soccer teams of the Ağrı province and who was not injured in the past year (Age 20,03±3,38, weight 65,69±10,66, height 176,61±8,72) participated in the study voluntarily. The lactic acid concentration of the participants at rest and their proprioceptive sense measurements were determined by standardized methods and materials. Then, Wingate test was applied to the participants. The lactic acid concentration and proprioceptive sense measurements were repeated at the end of the test. The analysis of the collected data was carried out through the SPSS 22 program. Shapiro-Wilks test was conducted for normality distribution. Independent-Samples t-test was carried out in the comparison of test and control groups and Paired-Samples t-Test was utilized in the comparison of differences between pretest and posttest means. It was concluded that lower extremity fatigue in soccer players has a negative effect on lower extremity proprioceptive sense ($p<0.05$).

Keywords: soccer, fatigue, proprioceptive sense, lactic acid, heart rate

1. Introduction

The aim of the study is to determine the effect of fatigue in soccer players on alt extremity proprioceptive sense.

Therefore, this study is important in terms of revealing the need for studying the effect of muscle fatigue on proprioceptive sense in soccer players with all its aspects and for the development of programs to prevent sports injuries.

Hypothesis of the study: Fatigue in football players, lower extremity proprioceptive sensation is the negative effect.

Literature Review: Fatigue occurs due to the combination of many consecutive factors and reduces athletic success and performance with the impairment of contraction force or strength (Kirkendall, 1990; Sharon and Denise, 2003; Billat, 2001; Olaru and Öztürk, 1994). In terms of athletes, fatigue is defined as “sensation of weakness, slowness and, sometimes, pain in muscles” (Billat, 2001). Muscular fatigue is defined as the insufficiency that occurs in the production or maintenance of a certain power through muscle contraction (Günay and Cicioğlu, 2001). Muscle fatigue is a risk factor for muscular and skeletal diseases. One of the negative effects of muscle fatigue is the fact that it causes decrease in performance (Ferraz et. al, 2012; Bompa, 1994). In sport branches, the level of fatigue affects competition results. Moreover, loss of competitions by a narrow margin at the elite level makes the study of the causes of fatigue and its toleration very important. Muscle fatigue studies are being carried out to minimize these undesired situations (Allison and Fujiwara, 2002; Klimek, 2010). Muscular fatigue is known to change the proprioceptive system, the central proprioception process and, at the same time, the power production capacity (Şimşek and Ertan, 2011). Proprioception is the position phenomenon of the joint and extremity provided by the neural stimulus that occurs through joints and receptors in tissues covering these joints (Hughes and Rochester, 2008; Hindle et. al, 2012). Proprioceptive sense plays a significant role in the provision and maintenance of joint stability (Erkmen et. al, 2007). The concept of proprioception is becoming more important in the etiology, diagnosis and treatment of sports injuries or joint diseases. It has been indicated that proprioceptive deficiency facilitates injuries, proprioception in joints deteriorate after injuries and proprioceptive rehabilitation decreases the frequency of injuries or accelerates the treatment process (Evans et. al, 2002).

2. Method

26 male soccer players who play licensed soccer in the amateur soccer teams of the Ağrı province (Age 20,03±3,38, weight 65,69±10,66, height 176,61±8,72) was included in the study. The content of the study was explained to every soccer player who agreed to participate in the study with all its details. Before the tests, all soccer players filled and signed the health questionnaire used in the determination of their health condition and the informed consent form that stated they participated in the study voluntarily. Weights and heights of the participants were measured respectively before fatigue. Blood samples were taken to determine lactic acid concentration, a 5-minute warm-up run was made and after their adaptation to the proprioceptive sense platform was ensured, proprioceptive sense measurements were conducted. Then, Wingate test was applied to the test subjects. After Wingate test, blood samples were taken to determine the lactic acid concentration that occurred due to fatigue and the research was finalized after the proprioceptive sense posttest measurements. This study was conducted at the Physiology Laboratory of Ağrı İbrahim Çeçen University, School of Physical Education and Sport.

Height and Body Weight Measurements:

The heights of the test subjects were measured by a height meter with a 0.01 m degree of accuracy (SECA, Germany) and body weight measurements were taken by an electronic scale with a 0.1 kg degree of accuracy (SECA, Germany) (Köklü et. al, 2009).

Body Mass Index (BMI):

BMI was calculated through the division of the body weights' kg value by the square of the heights' meter measurement (kg/m²) (Moran and McGlynn. 1996; Norris et. al, 2005; Taylor et. al 1998).

Fatigue protocol (Anaerobic Wingate Test):

Wingate Anaerobic Power Test was conducted to create fatigue in the soccer players in the test group. The ergometer of a monark brand 834E model bicycle with scales and a computer mechanism connected to the bicycle were used for the test. Before the test, a standard warm-up was carried out by the test group at the bicycle ergometer which consisted of a 6-minute exercise at 140-150 rate/min heart rate (HR) and 2-minute stretching exercises (Gökbel et. al, 1993). Saddle length of the bicycle was adjustedfor every test subject and 7,5% gr load per each kg their body weight was placed in the bicycle's saddle. The test subject who was subjected to a 30-second pedaled as fast as he could without getting upfrom the saddle throughout the test. When the test subject reached maximum speed, the load was removed and the test was started. The test subject was verbally motivated throughout the test and particularly in the last 10-15 seconds.

Determination of lactic acid concentration:

Blood samples were taken to determine the pretest and posttest lactate (lactic acid) concentration (La) of the test subjects). Blood samples for La were taken from earlobes and were immediately measured inYSI Sport 1500 LA analyzer (Yellow Spring Inst. USA) electroenzymatically with no processing. The analyzer was calibrated every test day in line with the manufacturing firm's guidance (Alemdaroğlu et. al, 2008).

Proprioceptive Sense Measurements:

Proprioceptive sense measurements were taken by using an isokinetic dynamometer of Pro-Kin, Technology, Dalmine, Italy brand (20 Hz sampling rate, sensitivity 0.1°, product type:PK252). Proprioceptive Sense Test was carried out by the selection of Multiaxial Proprioceptive Assessment Module with a proven validity and reliability (Tessalina et. al, 2016; Wang et. al, 2011) and the pressure level of the stabilometer was adjusted to the difficulty degree of 5 (out of 50) for this test (Göktepe et. al, 2015). The test subjects were asked to keep their hands on the handles of the device throughout the test. The test was completed by rotating the platform 5 times clockwise within 60 seconds by following the round route on the screen (Göktepe et. al, 2015; Song et. al, 2013; Göktepe et. al, 2015).

Data Analysis:

Statistical assessment was made through the SPSS 22.0 (SPSS Inc., Chicago, IL, USA) program. Collected data is presented as means and standard deviation. Shapiro-Wilks test was conducted for normality distribution. As the data exhibited normal distribution, parametric tests were chosen. Paired-Samples t-Test was utilized in the comparison of differences between the pretest and posttest means of the soccer players. The results were assessed in the 95% confidence interval and $p<0.05$ was considered significant.

3. Results

In Table 1, age, body weight, height, body mass index and sports age of the participant soccer players are 20,03±3,38 years, 65,69±10,66 kg, 176,61±8,72 cm, 20,97±2,52 kg/m2 and 9,31±3,35 years respectively.

Table 1. Physical characteristics of participant soccer players

N	Age (year) (Mean ±SD)	Body Weight (kg) (Mean ±SD)	Height (cm) (Mean ±SD)	BMI(kg/m2) (Mean ±SD)	Sports Age (year) (Mean ±SD)
26	20,03±3,38	65,69±10,66	176,61±8,72	20,97±2,52	9,31±3,35

Table 2. Descriptive statistic of soccer players' Wingate test scores

Test: (N:26)		(Mean±SD)
WINGATE	PP [W]	704,90±238,46
	AP [W]	533,34±165,08
	MP [W]	332,75±94,51
	FI	52,79±12,03

PP: Peak Power, AP: Avg. Power, MP: Min. Power, FI: Fatigue Index

The descriptive statistic of soccer players' Wingate test scores in the test group were found PP(w) 704,90±238,46, AP(w) 533,34±165,08, MP(w) 332,75±94,51, FI 52,79±12,03 in Table 2.

Table 3. Dependent t-Test Results Conducted to Test the Significance of the Difference Between the Pretest and Posttest of Soccer Players' Heart Rate, Lactate and Proprioceptive Sense Scores

			N	X	SS	SD	t	p
PROPRIOCEPTIVE	SI (°)	Pretest	26	0,95	0,55	31	6,47	**0,00***
		Posttest	26	1,45	0,59	31		
	AFV (kg)	Pretest	26	1,38	0,62	31	1,21	0,23
		Posttest	26	1,64	1,07	31		
	ATE (%)	Pretest	26	28,69	10,31	31	7,75	**0,00***
		Posttest	26	36,72	12,81	31		
	LA (mmol/L-1)	Pretest	26	1,36	0,15	31	50,51	**0,00***
		Posttest	26	4,62	0,31	31		

***(p < 0.05) SI: Stability indicator, AFV: Average force variance, ATE: Average tracking error.**

Considering the pretest and posttest dependent t test results of the participant soccer players in Table 3, no statistically significant difference was found for Proprioceptive Sense (AFV) values (p>0,05). A significant difference was detected for LA, Proprioceptive Sense (SI) and (ATE) values (p<0.05). After the fatigue protocol applied to soccer players, a significant difference was found in favor of LA and Proprioceptive sense values.

4. Discussion

Proprioceptive abilities have a very important effect on athletic performance. Performance improvement of athletes and decrease in injuries during sports activities depend on proprioceptive abilities as the majority of sports activities is implemented at high speed (Laskowski et. al, 2000). Even though the most frequently assessed parameter of proprioception is the sense of joint position, there is no standard measurement method. There are different measurement methods for proprioceptive sense. In this study, isokinetic dynamometer measurement method was used (Laskowski et. al, 2000; Dover and Powers, 2003; Voight et. al, 1996).

After the fatigue protocol was applied to soccer players, a regression was detected in lower extremity proprioceptive sense parameters.

Skinner et. al (1986) evaluated the pre and post protocol position sense on the knee they applied the fatigue protocol to and found a difference that indicated a clear decrease in joint position sense in pre and post fatigue measurements. Miura et. al (2004) conducted a study in which they examined the effect of local and general fatigue on knee proprioception. In this study, local fatigue occurred as maximum isokinetic knee flexion and extension at isokinetic dynamometer and general fatigue occurred as a 5-minute run on a treadmill. No change was observed in knee proprioception scores after local fatigue but values dropped after general fatigue. After a bicycle exercise Roberts et. al (2003) carried out on a Borg scale prepared for the perception of fatigue which the test subjects did until oxygen perception reached a stable level, a regression occurred in knee joint proprioception values after the exercise. Johnston et. al (1998) found that motor control performance decreased significantly in post-fatigue values created by using an isokinetic dynamometer. These results comply with this study's results.

Myers et. al (1999) created fatigue in the shoulder by implementing an internal and external rotation exercise with an isokinetic dynamometer, made a comparison by taking the pre and post-exercise active position sense and found a clear difference between pre and post-fatigue values. In a study carried out by Carpenter et. al (1998), the effect of muscle fatigue on knee proprioception was examined in 20 subjects with no shoulder problems. Proprioception was tested first when the subject were at rest and then after they exercised on an isokinetic test machine until they were fatigued and it was finally reported that fatigue cause a decrease in the proprioceptive sense. Zabihhosseinian et. al (2015) believe that upper extremity proprioception may deteriorate after fatigue. As deteriorations occurred in upper extremity proprioceptive sense according to the results of these studies, they partially support the results of this study.

Ageberg et. al (2004) created fatigue in patients with chronic anterior cruciate ligament injury who did not have an operation by using a submaximal bicycle exercise with short resting periods. They assessed pre and post-exercise conditions by stability test and found no difference between the patient group and the control group in terms of exercise effect. Brown and Bowyer (2002) investigated the effect of fatigue in university students on ankle stability and proprioception. In measurements taken after the exercise, ankle stabilization was found to be increasing despite muscle fatigue. This was attributed to the fact that moderate activities stimulated neuromuscular neurons and increased the perception power of joint positions. As a result of this study, it can be said that submaximal loading affects the sense of proprioception positively. In a study carried out by Miura et. al, (2004), no significant variability resulting in a decrease at the expected level was observed in the proprioception assessment based on joint position sense perceptions in the closed kinetic systems of the test subjects. The results of the studies conducted by Brown and Bowyer (2002), and Miura et. al, (2004) support the results we obtained in our study. With exercise, viscoelastic properties of muscle improve, they get better oxygen and vasodilatation occurs as a result of the increase in body heat. These physiological changes improve the receptor functions in joint and neuromuscular structures (Astrand et. al, 1986). For instance, when body heat increases, pyrexia threshold value of skin receptors falls and, thus, the sensitivity of the sense of touch increases. In a similar vein, response of muscles to central orders changes positively with exercise. As a result, stimulus thresholds of mechanoreceptors in muscles fall. All these changes are reported to positively increase the sense of joint position (Astrand et. al, 1986; Bouet and Gahery, 2000; Hazneci et. al, 2005; Miura et. al, 2004).

Waddington et. al, (1999) carried out wobble board training on rugby players for 5 weeks and observed development in both ankle and knee joint position sense of the athletes after exercise. Friden et. al (2001) stated that neuromuscular, proprioceptive and field-specific exercise programs may develop knee joint proprioception. In a study carried out by Aydın et. al (2002), ankle balance and proprioception of 20 healthy control and 20 young female gymnasts and gymnastic exercises were found to have a positive effect on the perception of the ankle position. Panics et. al (2008) conducted a 16-week proprioceptive exercise method on female handball players and found that proprioceptive exercise developed the knee joint proprioception considerably and the difference was significant compared to the control group. Ashton et. al (2001) discussed whether exercise develops proprioception and could not reach a clear conclusion. In a study carried out by Tsang et. al (2005), adults who practice Tai Chi regularly were found to have stronger knee muscle strength and better balance scores than the control group.

In the light of the conducted studies, proprioception is believed to be attainable and practicable (Barrack et. al, 1984). According to numerous studies in the literature, people who exercise more regulary have a better balance and proprioceptive sense than those who do not exercise (Aydın et. al, 2002; Barrack et. al, 1984; Barrack et. al, 1983). Proprioceptive mechanism plays a role in the stabilization of joints and provides the interaction between capsuloligamentous structures and dynamic muscular force (Sharma, 1999; South and George, 2007).

Acute and mild warm-up exercises and stretches (Bartlett and Warren, 2002) strengthens the neuromuscular protective mechanisms of reflexes by increasing the mechanoreceptor sensitivity of long-term mild and tiring exercises, i.e. they affect the balance and joint position sense positively. However, movements acutely made at fatigue level impairs muscle spindle and GTO activity and affects joint position sense negatively. As a result, athletes are exposed to injuries (Bartlett and Warren, 2002). Acute and chronic period results are partially similar. However, acute period tiring activities are believed to have a bigger negative effect on proprioceptive sense.

5. Conclusion

It was concluded that lower extremity fatigue negatively affects lower extremity proprioceptive sense in soccer players. In other words, proprioception and fatigue are negatively correlated.

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