

Field : Coaching

Type : Research Article

Received: 13.11.2017 - Accepted: 08.12.2017

Effects of High Intensity Interval Training on Balance Ability and Recovery Time in Soccer Players

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Abstract

Specifically, high intensive interval training (HIIT) may induce fatigue, which is a natural physiological response. Fatigue decreases dynamic balance ability and subsequently may negatively affect technical performance such as passing, shooting and dribbling. These technical skills are an important component of soccer players. Therefore, the aim of this study was to investigate the effects of HIIT on balance ability and the time required for turning back to baseline in young athletes. Twenty one soccer players (12 males, 9 females, age = 21.76 ± 3.09 years; weight = 64.5 ± 9.8 kg; height = 169.4 ± 7.18 cm) having no history of lower extremity injury participated in this study. The Biodex SD balance system was used in order to determine the non-dominant athletic single-leg stability. To become familiar with athletic single leg balance testing on the BBS, the subjects performed six practice testing sessions within a week. Monark cycle ergometer was used for high intensity anaerobic exercise. Each subject performed four maximal efforts cycling on an electronically braking cycle ergometer against a resistance equivalent to 0.075kg/kg body mass for 30 seconds with three-minute rest intervals. Subjects were verbally encouraged to continue pedaling as fast as possible throughout the each test. After four maximal cycling, subsequently subjects performed athletic single leg stability test and then repeated same test with a five-minute passive rest period for 4 times. The result of this study has indicated that, HIIT negatively effects single leg dynamic balance ability ($p < 0.05$). Furthermore, single leg balance ability turn to the baseline status after 10 minutes passive recovery duration ($p > 0.05$).

Keywords: Balance, Fatigue, HIIT, Recovery, Soccer, Support Leg

Introduction

The balance is defined as vertically keeping the body's center of gravity within the base of support by means of feedbacks coming from visual, vestibular, and somatosensorial structures and performing the regularly coordinated neuromuscular movements (Nashner, 1997). Balance skill is a key factor in order to show the optimal performance in soccer (Pau et al., 2016).

Showing the technical skills is one of the most important components in soccer (Stolen et al. 2005; Stone and Oliver 2009). High performance especially in technical skills such as passing, shooting, and dribbling plays important role in achieving the success in soccer (Stone and Oliver 2009; Ali et al. 2007; Lago et al. 2010). The performance of technical actions such as shooting, dribbling, and passing requires maintaining the balance over the support leg (Paillard and Noe 2006). Many of the technical skills are performed in unstable situations in soccer. The soccer players generally use their non-dominant legs in performing technical skills. Especially in performing various technical skills such as passing, shooting, and dribbling, the support leg plays important role in sustaining and maintaining the body balance (Teixeira et al. 2011). In a study, in which the center of pressure (COP) velocity was measured before the soccer game, in half-time, and after the game, it was determined that the balance ability of support leg has decreased (Pau et al., 2016).

The fatigue is an important factor acutely influencing the balance ability. There are many studies reporting that the balance ability is negatively affected after the fatigue (Toshimitsu et al., 2011; Susco et al., 2004; Fox et al., 2008; Paillard, 2012). Depending on the frequency, intensity, and duration of exercise that is performed, the fatigue is divided into two based as peripheral and central nervous system fatigues (Millet et al., 2004; Glaister, 2005). Aerobic activities influence the central nervous system, whereas the anaerobic activities cause peripheral nervous system fatigue (Millet et al. 2004; Glaister, 2005). Peripheral fatigue originates from inability of meeting the sufficient energy for the muscles despite the increasing energy requirement (Glaister, 2005). During a 90-minute soccer game, the soccer players perform high-intensity activities approx. once every 70 seconds. In a study, it was reported that soccer players perform high-intensity movements such as sprint, change of direction, acceleration, deceleration, and jumping for approx. 150-200 times (Bangsboo, 1994). As a result of these high-intensity activities, the fatigue level increases and the technical skills and performance of players are negatively affected (Lyons et al., 2006; Rampini et al. 2009). As well as the physical performance (Mohr et al., 2005) and technical skills (Russel et al., 2011), also the balance ability is influenced as a result of deterioration in quality, efficiency, and related motor outcomes of sensorial inputs (visual, vestibular, and proprioceptive) (Paillard, 2012).

In many studies, it has been shown that there is a relationship between soccer-specific technical skills and balance ability (Paillard and Noe, 2006). Moreover, it is known that, when compared to the low-level soccer players, the high-level soccer players have better technical skills and also better balance abilities (Paillard et al., 2006). Top level soccer players feel fatigue in last 15 minutes of both halves (Krustrup et al., 2005; Mohr et al., 2005). Besides that, the deterioration of balance abilities of soccer players occurred in last 15 minutes of both halves and soccer-specific fatigue affects the functional stability of players during the game (Greig and Walker-Johnson, 2007). Rampini (2007) reported that the deterioration was observed in passing skills of players after high-intensity activities. For this reason, it can be thought that the decreases in technical skills of players at the last moments of games might be related with the deterioration of balance abilities.

To date, the effects of fatigue on balance performance were analyzed in numerous studies. But, in many of these studies, the authors focused on the effects of fatigue on double leg or dominant leg balance abilities. However, many soccer-specific technical skills require support leg balance ability. For this reason, the aim of this study is to investigate the acute effects of high intensity interval trainings (HITT) on support leg balance ability and the recovery period of impaired balance ability.

Method

12 male and 9 female soccer players were involved in this study (age: 21.76 ± 3.09 years, weight: 65.5 ± 9.84 kg, height: 169.42 ± 7.18 cm; training age: 6.38 ± 1.93 years; Body Mass Index: 22.34 ± 2.17). The subjects voluntarily participate into this study. The players, who had ankle, knee, and joint injuries in last 6 months, were not involved. The participants didn't perform exercise, which cause fatigue, during 48 hours before the tests. The participants were asked to not use matters such as alcohol and caffeine, which have stimulant effect, in last 24 hours.

Table 1. Descriptive Information of Participants

	Age (years)	Height (cm)	Weight (kg)	BMI (kg/cm ²)	Training age (years)
Males	23.58 ± 2.90	173.33 ± 6.27	69.45 ± 9.13	22.99 ± 2.22	6.19 ± 1.08
Females	19.33 ± 0.86	164 ± 4.65	57.91 ± 6.45	21.47 ± 1.88	5.11 ± 1.05
Mean	21.76 ± 3.06	169.42 ± 7.18	64.5 ± 9.84	22.34 ± 2.17	6.14 ± 1.38

BMI: Body Mass Index

High Intensity Interval Training

Anaerobic fatigue protocol was executed using Wingate cycle ergometer. In high intensity interval training protocol, the participants were asked to pedaling at maximum speed for 30 seconds. The intensity of training was set to the weight load level corresponding to 7.5% of body weights of participants. The scale fell when the tire speed of cycle reached at 150 rpm after the participant started pedaling. Then they continued pedaling maximally for 30 seconds. The soccer players were verbally motivated throughout the training. They repeated the Wingate test protocol for 6 times with 4 minutes interval.

Balance Tests

Biodex SD (Biodex, Shirley, NY) athletic single leg test protocol was applied to the participants. In order to prevent the learning effect, the subjects performed balance test familiarization during 5 days in last week before the test. Athletic Single Leg test protocol consisted of 3 repeats of 20-second session with 10 second interval. The intensity level of test was set 4th level. During the test, the participants were allowed to place their feet in the way they wanted. The balance tests were carried out with subjects on their support leg in akimbo position. The subjects were asked to keep their dominant leg at 45° flexion. The participants

were taken into balance test immediately after the end of HITT protocol. The after-fatigue balance tests were carried out at 0th, 5th, 10th, 15th, and 20th minutes with 5 minutes interval. The participants were allowed to rest passively during their 5-min recovery period.

Lactate Test

The blood lactate levels of participants were analyzed right after the fatigue protocol and right before the balance test at 0th, 5th, 10th, 15th, and 20th minutes of recovery period. For the lactate test, the fingertips of subjects were cleansed using a paper tissue soaked with alcohol, and the capillary blood sample was taken by using lancet. Blood lactate level was measured using Accutrend Plus (Roche Diagnostics, Basel, Switzerland) blood lactate analysis device.

Statistics

The data were analyzed using SPSS 22.0 package software. In order to identify the participants before the test, the mean and standard deviation values of age, height, weight, BMI, and training age parameters were calculated. Balance test scores before HITT, immediately after HITT, and at 0th, 5th, 10th, 15th, and 20th minutes and the blood lactate values were analyzed using Repeated Measurement ANOVA method. Benferroni Post Hoc test was employed in order to determine from where the difference originated. For all the analyses, the level of statistical significance was set at $p < 0.05$.

Findings

At the end of study, it was determined that the balance abilities of players significantly decreased at the end of HITT ($p < 0.001$).

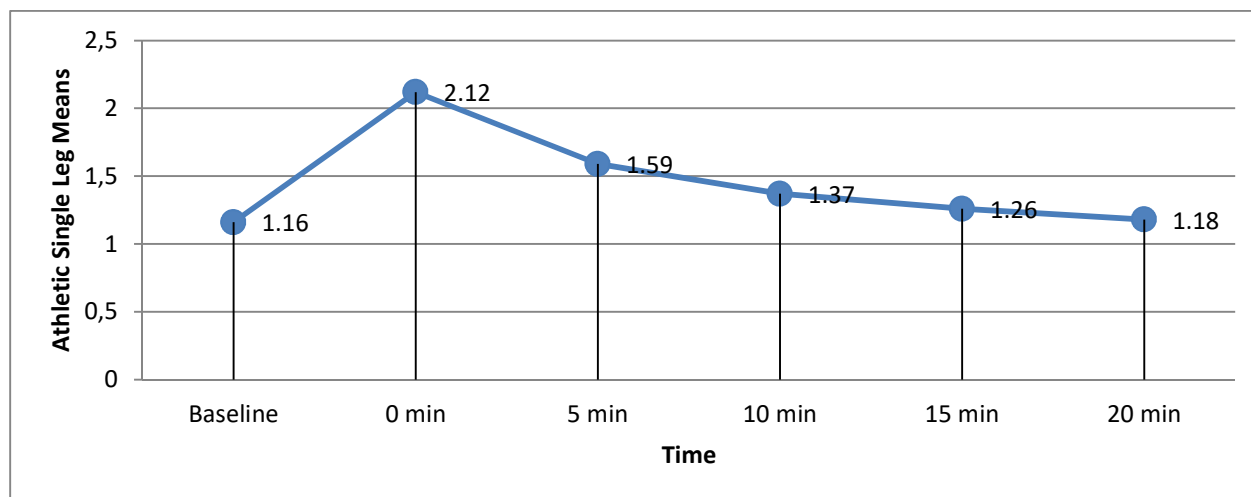


Figure 1. Mean Values of Repetitive Measurement Athletic Single Leg (ASL) Balance Test

In Figure 1, the mean values of players' athletic single leg balance test before HITT and at 0th, 5th, 10th, 15th, and 20th minutes after HITT are presented.

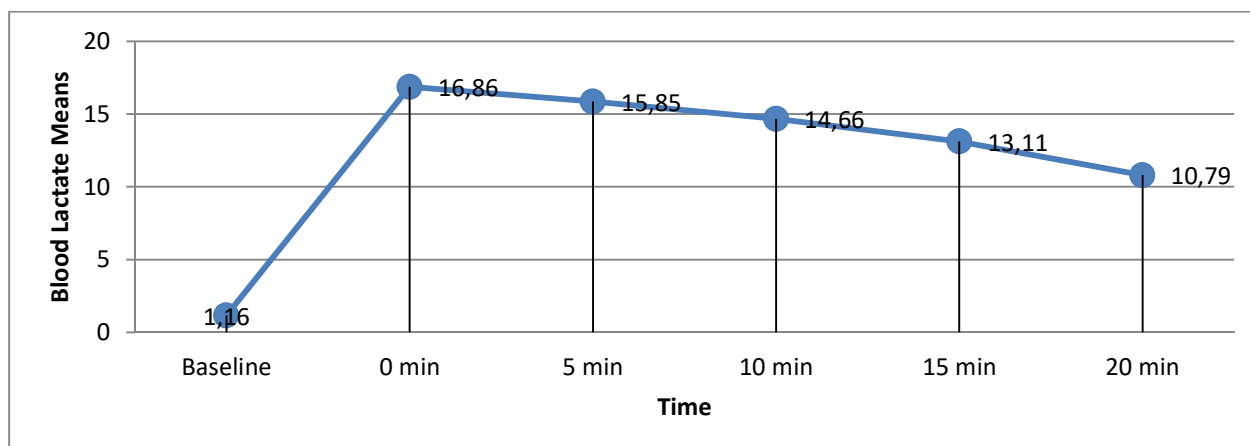


Figure 2. Repetitive Measurements Lactate Test Mean Values

In Figure 2, the mean blood lactate level values of players before HITT and at 0th, 5th, 10th, 15th, and 20th minutes after HITT are presented.

Table 2. Statistical analysis results of Repetitive Measurement Balance and Lactate Tests

	Time Interval	Mean Difference	Std. Error	Sig.
Athletic Single Leg Baseline	Post-Test	-.967*	.162	.001
	5 min	-.429*	.104	.008
	10 min	-.214	.078	.189*
	15 min	-.105	.037	.150*
	20 min	-.024	.028	1.000*
Lactate Test Baseline	Post-Test	-15.7	0.61	0.001
	5 min	-14.69	0.55	0.001
	10 min	13.5	0.71	0.001
	15 min	11.95	0.68	0.001
	20 min	-9.63	0.77	0.001

* $p > 0.05$

In Table 2, a statistically significant difference was found between the pre-test and post-test values ($p < 0.001$). Moreover, there is a statistically significant difference between the pretest value and the value observed in balance test at 5th minute ($p < 0.05$). No statistically significant difference was observed between the values obtained before HIIT training and the values obtained from balance test at 10th, 15th, and 20th minutes ($p > 0.05$). A statistically significant difference was observed between the pre-training blood lactate levels and the values obtained after training and at 0th, 5th, 10th, 15th, and 20th minutes.

Discussion

The aim of present study was to examine the acute effects of HITT on support leg balance ability of soccer players. At the end of this study, it was determined that the HITT acutely and negatively affected the support leg balance ability ($p < 0.05$). Moreover, it was also determined

that it took approx. 10 minutes for the support leg balance abilities to turn back to baseline ($p>0.05$). But, the post-training blood lactate values were observed to not turn back to baseline in 20 minutes after the training ($p<0.05$).

There are many studies reporting that balance ability has been negatively affected after the fatigue (Toshimitsu et al., 2011; Susco et al., 2004; Fox et al., 2008; Paillard, 2012; Cetin et al., 2008). Depending on the intensity, frequency, and duration of performed exercise, the fatigue is divided into two groups as peripheral nervous system fatigue and central nervous system fatigue (Millet et al., 2004; Glaister, 2005). Aerobic activities influence the central nervous system, whereas the anaerobic high-intensity activities cause peripheral nervous system fatigue (Millet et al., 2004; Glaister, 2005). The peripheral nervous system fatigue originates from the inability of providing muscles with sufficient energy despite the increasing energy requirements (Glaister, 2005). The most significant indicator of peripheral nervous system fatigue is the blood lactate level (Finsterer, 2012). In this study, the blood lactate levels significantly increased after HITT (16.86mMol/L) ($p<0.001$). It can be obviously seen that the trainings performed caused peripheral nervous system fatigue.

In this study, the support leg balance ability turned back to its initial level within 10 minutes after the HITT exercise. Similarly, in a study carried out using cycle ergometer, the participants performed 2 repeats of 30-second Wingate test with 2 minutes interval. Similarly with the results obtained from that study, it was also observed in this study that the balance abilities were negatively affected after high-intensity activity, and that the initial levels were achieved in 10 minutes (Yaggie and Armstrong, 2004). Moreover, in a study involving 11 male and 7 female soccer players, the fatigue protocol was applied to the players. According to the results obtained from Biodex Limit of Stability Test applied after fatigue, it was determined that the test results turned back to baseline in 10 minutes (Toshimitsu et al., 2011). In addition to that, in a study employing aerobic and anaerobic load protocols, it was observed that the balance ability turned back to initial levels in 8-13 minutes in both loading methods (Fox et al., 2008). On the contrary with these studies, there also are studies reporting that recovery period took more than 10 minutes, as well as the studies reporting that the balance ability was not affected after the fatigue. In a study employing exhaustion protocol including sportive activities, the balance test results indicated that the baseline was re-achieved in 20 minutes (Susco et al., 2004).

In a study, in which Biodex balance system was used for balance measurement before the soccer game and in half-time, a decrease was determined in dominant leg balance performance, whereas no effect was observed in support leg (Yamada et al., 2012). In this study, it was determined that the support leg balance performance significantly reduced after HITT activity. The reason of difference observed here is believed to arise from difference between the balance test levels. Moreover, the reason of difference between dominant and non-dominant legs might be the balance performance of non-dominant leg of soccer players better than that of dominant leg. In literature, there also are studies reporting no change in balance performance after the fatigue. In balance measurements performed using Biodex balance system after soccer-specific fatigue (Greig and Walker-Johnson, 2007) and soccer training (Gioftsidou et al., 2011), it was reported that the balance performances of soccer players were not affected from fatigue. Paillard (2012) reported that the recovery of balance ability values to baseline after the fatigue depends on the duration, frequency, and intensity of fatigue protocol. It is believed that the reason for no difference in balance ability after the fatigue might be that the fatigue protocol was not applied at sufficient intensity and frequency in those studies.

Soccer game involves many high-intensity activities (Bangsboo, 1994; Stolen, 2005). During these activities, the soccer players maintain their balance on their support legs in order to show optimal performance (Teixeira et al., 2011). In a previous study, it was shown that there is a positive relationship between the support leg balance ability and shooting skills (Tracy et al., 2012). The decrease in balance performance of support leg after the performance is believed to be related with decreases of players' technical skills during last 15 minutes of both halves. In further studies, the aerobic endurance and recovery skills of soccer players might be examined together with the balance performance. Moreover, it is not clear yet how the balance exercises would affect the balance performance during fatigue. For this reason, it is recommended to carry out studies on these subjects in future.

Conflicts of Interest

The authors have no conflicts of interest to acknowledge.

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