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The Effects of Neuromuscular Fatigue on Functional Movement and Balance Performance in Youth Football Players

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Abstract

The aim of this study is to examine the effects of neuromuscular fatigue on functional movement analysis total score and balance ability. 28 professional football players participated in the study voluntarily. A 10-meter running and vertical jump test was used to assess neuromuscular fatigue in football players. Functional movement skills were made with the functional movement imaging method. Balance skill was measured with the modified Y balance test. Statistical analysis of the data obtained in the study was carried out with the t-test in paired samples. According to the t-test results in paired samples, the average functional movement total scores of the football players who participated in the study were 15.64 ± 2.34 while they were at rest, while the functional movement analysis total scores after fatigue were 13.78 ± 2.29. It was statistically determined that fatigue negatively affects functional movement and balance skills ($p<0.001$). Preventing or reducing fatigue in footballers affects functional movement and balance skills and increases the risk of injury. Therefore, delaying fatigue and accelerating recovery may be important to prevent injuries.

Key Words: Balance, functional movement, football, fatigue

INTRODUCTION

Football is a popular game with more than 240 million licensed athletes in the world. Many high-intensity movements are repeated hundreds or even thousands of times in one football match. These movements are usually repeated at high intensities from the beginning until the end of the football match. Fatigue during the match disrupts the patterns of these movements and increases the risk of injury. Many non-impact injuries in football matches are caused by deterioration of movement patterns while performing a technique as a result of fatigue. Improper technique leads football players to perform the work by consuming more energy and creating more load on the muscles, tendons and ligaments which if this load is not familiar, may

cause risk of injury.

Functional Movement Analysis is a movement scanning method used to monitor postural control, joint stability, and basic movement pattern quality in athletes (8,12). FMS is designed to evaluate a variety of skills that are necessary to participate in higher level functions. FMS requires the ability to move through three planes of movement (7). FMS is a movement scanning system that is based on seven different movement patterns and analyzes them according to predetermined scoring criteria (1). Functional movement analysis aims to evaluate postural control and obtain information about deficiencies or limitations that occur during the implementation of basic movement patterns. Functional movement analysis helps athletes evaluate various physical skills such as asymmetry between extremities, trunk stability, joint mobility, balance, neuromuscular control and coordination, strength and flexibility (9). It is stated that functional movement analysis is a movement screening test that can be used to determine and prevent injury risks not only in adult athletes but also in young and adolescent athletes. (9,15)

Screening tests that might identify modifiable intrinsic risk factors for musculoskeletal injury are appealing to applied practitioners working in sport and exercise medicine (13). In studies, the Functional Movement Analysis , which is a screening test, total score below 14 is considered as an injury risk (2,16). Functional Movement Analysis should be applied to athletes while they are at rest to acquaire a reliable results. As a result of the FMS applied in rest state, the test result may identify if there is no previous injury, lack of strength or imbalance in the movement patterns of the players (20).

Injuries in football matches occurs due to various reasons; insufficient warm-up at the beginning of the first and second half or due to fatigue accumulated at the end of the first and second half football, tackling or injuries caused by player to player contact, surface related injuries (10,14). Considering the FMS is better when using this test while at rest, the focus on this examination will be on injuries due to fatigue. As a result of high-intensity activities during a football match, energy reserves are depleted and fatigue occurs. In addition, neuromuscular fatigue (18) occurs because high-intensity repetitive activities require high motor activity. Neuromuscular fatigue is a condition that occurs in the neural networks between the central nervous system and muscles (6). As a result of neuromuscular fatigue, there are deteriorations in the excitation and contraction rates of the muscles. Therefore it may cause decrease of voluntary muscle contractions and the amount of force produced. The decrease in the amount of force produced, slowing down of muscle contractions causes movement patterns to deteriorate and the risk of

injury in football players increases (19).

Balance performance is important to maintain many athletic movements correctly.). Neuromuscular fatigue also negatively affects static and dynamic balance (3). Especially in football, static and dynamic balance must be maintained while displaying technical skills (passing, shooting, dribbling). Apart from this, in football competitions, football players need dynamic balance in many positions such as running, changing direction, acceleration and deceleration, jumping and falling. Loss of balance during these movements can cause falls and injuries. In a study conducted with female football players, it was stated that phyisological loads negatively affect balance performance and a period of at least 10 minutes is needed for regaining the ability of performing movements with balance as same as resting state. (11). In the same study, the effect of fatigue caused by the central nervous system on balance performance and the effect of peripheral fatigue on balance performance were compared. No statistical difference was detected between central nervous system fatigue and peripheral fatigue.

METHODS

A total of 20 football players playing in Kocaelispor U21 football team participated in this study. Functional movement analysis scores and balance skills of the football players were measured while they were at rest. Then, the neuromuscular fatigue protocol was applied and the FMS and Balance tests of the football players were repeated.

Functional Movement Analysis (FMS)

FMS test is a test that can be performed to evaluate functional movement. This test consists of seven movement patterns. The movements in this test are deep squatting, high stepping, single-line lunge, shoulder mobility, active straight leg lifting, trunk stability push-ups, rotation stability, respectively. The score of the FMS test is the total score obtained from the scores of the movements. Each move is scored between 0-3 points. Each individual participating in the evaluation can receive a score between 0-21. In calculating the total score, the lower score from the bilateral subtests is taken. Among the subtests, there is a "clearing test" for shoulder mobility, trunk stability push-ups and rotation stability tests.

Y- Balance Test

This test is a modified version of the Star Excursion Balance Test. This test involves reaching in the anterior, posteromedial (PM), and posterolateral (PL) directions. In the test, the angle

between the anterior-posteromedial and anterior-posterolateral directions is 135˚, and the angle between the posteromedial-posterolateral directions is 90˚. Participants lay down in three directions without changing their positions, with both hands on their waist and the sole of one foot maintaining contact with the ground. The test was performed as right foot anterior, left foot anterior, right foot PM, left foot PM, right foot PL, left foot PL. Both sided lower extremities were tested. Before the test, participants were made to practice reaching in all directions to help them learn the test. In the test, 3 reaches were made in each of the 3 directions (anterior, PM, PL) and the average of the 3 reaches for each direction was taken. Values are recorded in cm. Reach distances were normalized as a percentage by dividing the average value by the length of the lower extremity and multiplying by 100 (5,17).

Fatigue Protocol

A vertical jump test will be performed to evaluate neuromuscular fatigue. Jumping height will be measured using the Fushion Sport splash mat. The best jump height will be recorded and used to detect neuromuscular fatigue. After the jump height is determined, the athlete will be asked to sprint 6 times in a row in a 10-meter area and the vertical jump test will be repeated immediately afterwards. This protocol will continue until a score 30% lower than the athlete's best vertical jump height is achieved. If the Vertical Jump height is below 30%, it will be considered that sufficient neuromuscular fatigue has occurred (21).

FINDINGS

Table 1. Descriptive statistics

	Minimum	**Maximum**	**Mean**	**Standard Deviation**
Age	16	35	27	5.59
Heigth	165	188	176.03	6.25
Body Mass	65	80	71.07	4.01
BMI	20.98	25.45	22.97	1.02
Fat Ratio	6	14	9.32	2.46

According to the t-test results in the paired samples, the average functional movement total scores of the football players participating in the study measured while at rest were 15.64±2.34, while the total scores of the functional movement analysis performed after fatigue were determined to be 13.78 ± 2.29.

According to the results of paired sample t test statistical analysis, a statistically significant difference was detected between the functional movement total score measured before fatigue and the functional movement analysis total scores measured after fatigue (p=0.001).

Table 2. Comparison of FMS and Y Balance Test

	Pre-Test	Post-Test	Mean Difference	*p*
FMS	15.64 ± 2.34	13.78 ± 2,09	1.64 ± 1.54	0.001
Y Balance Test	95.11± 8.85	93.18 ± 7,06	2.11 ± 1.57	0.042

According to the t-test results in the paired samples, the average Y balance test total scores of the football players participating in the study, measured at rest, were 95.11±8.85, while the Y Balance Test total scores after fatigue were determined to be 93.18±7.06. According to the results of the paired sample t test statistical analysis before fatigue, a statistically significant difference was detected between the Y balance test total score measured at rest and the Y balance test total scores measured after fatigue (p=0.001).

DISCUSSION & CONCLUSION

Football is one of the sports where sports injuries occur most frequently in the world. The frequency of injuries in football varies depending on the morphological and anthropometric characteristics of the athletes. Especially young football players can be injured much more frequently than mature football players (4,18). In addition, most of the injuries seen in young football players involve lower extremity injuries.

It is thought that one of the main reasons for injuries in football players is fatigue. As a result of this study, it was determined that functional movement and balance tests performed after the fatigue test were worsened compared to the resting state. Impairment of functional movement and balance after fatigue is an important cause of disability. In a study conducted with female football players, it was stated that aerobic and anaerobic loads negatively affect balance performance and a period of at least 10 minutes is required for balance performance to return to resting level (11).

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