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The effect of quadriceps femoris and hamstring muscular force on static and dynamic balance performance

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Abstract
This study has been conducted in order to investigate whether quadriceps femoris and hamstring muscular force of elite athletes having an active sports life, affects the static and dynamic balance performance.
The study has included 16 elite athletes with an active sports life totally. Quadriceps femoris and hamstring muscular force of the athletes have been measured by Pressure Air Biofeedback Test method. The balance performances have been evaluated by using Biodex Balance System, and determined as dynamic and static. Pearson Correlation test has been applied in the statistical evaluation of the study. It has been found out that the static balance performances and oscillation indexes of the athletes have not changed in accordance with femoris muscular force of the athletes ($p>0.05$). When dynamic balance performances are taken into consideration, it has been detected that as difficulty level increases, quadriceps femoris muscular force also affects the balance performance ($p<0.05$). No significant difference has been found between the hamstring muscular force and static and dynamic balance performances of the athletes ($p>0.05$).
According to the results obtained, quadriceps femoris muscular force of the athletes affects the balance performances, and as balance difficulty level increases, quadriceps femoris muscular force maintains the balance. However, hamstring muscular force does not affect the balance performance. In conclusion, it has been detected that quadriceps femoris muscular force may be effective in the sports branches that put an emphasis on the balance; the muscle must be strengthened and should not be forced when it is damaged.

Keywords: Balance, Quadriceps Femoris, Hamstring, Strength.

1. Introduction
Muscular force can be defined as the strength against the resistance with a maximal effort of a muscle or muscle group. Muscular force can be evaluated as isometric, isotonic or isokinetic. Isokinetic strength is the highest torque value that can be performed during the contraction occurring with a certain speed [1]. The balance is defined as the ability of maintaining the position of the body on the support area and it forms a basis for a better performance [2]. The ability of human beings in redressing balance is a determinant for developing other motor systems. For human body, balance is maintaining the alignment of the body under the effects of gravity, internal and external forces, and minimizing the total of the forces affecting the body [3]. In upright position, the individuals maintain the balance control by performing minimal motions by means of different parts of their bodies. In order to maintain the balance, center of mass of the body must pass through an appropriate area of the sole. Moreover, sensorial system, musculoskeletal system and central nervous system must work in a coordinated manner. Musculoskeletal system plays a sensorial role by means of proprioceptors provided therein, and a mechanic role as an operator of the motion in maintaining the balance. It is asserted that the most important muscles in maintaining the balance are dorsal muscles, Quadriceps femoris, hamstring muscles and soleus muscle [4]. When the proteins such as actin and myosin, which form the structure of the muscle cell, lose their properties during the exercises and the functioning of sarcomeres is prevented, the functions of the muscle are also affected negatively [5]. The control of the balance is a complex motor skill including the integration of the required sensorial inputs, planning the several

movement types such as flexibility and applying thereof [6]. It is stated that elite athletes present different forms of balance control as a result of their sports branches. Taking active role in a sports branch for a long time and exercising may improve the effectivity of dynamic and static control [7]. The balance is adjusted by the required systems constantly. Weakness or lack of symmetry of the muscles that provide the balance in the body for any reason, may lead to certain health problems [8].
The aim of this study is to investigate the effect of quadriceps femoris and hamstring muscular force of elite athletes having an active sports life on the static and dynamic balance performance.

2. Materials and Methods

The study has included 16 elite athletes, who have an active sports life and accepted to be included in the study voluntarily, and did not have any neurologic diseases, vestibular-visual disorders in the last one year or did not have any serious lower extremity disabilities in the last 6 months. The athletes included in the study have an average age of 23.43±2.80 years, average height of 173.43±7.33 cm, and average weight of 81.37±18.23 kg.

2.1. Muscular Force Measurement

While quadriceps femoris and hamstring muscular force of the athletes have been measured by calibrated Pressure Air Biofeedback (PAB Test Manual) Test method, the muscular force parameters have been measured as total work, average, maximum and relative.

2.2. Static Measurement

Biodex Balance System (BSS) (Biodex, Inc, Shirley, New York) has been used for measuring the balance in the study. Biodex balance device consists of a mobile platform that enables the participant to stand still and to move forwards, backwards and sideward. OA index balance ability is accepted as the best indicator among the balance indexes received. The high OA index value means that there is an excessive loss of balance. “0 degree” balance scores indicate the possible maximum balance. The platform has a mobility degree between 0 and 12. While 12 is the most stable platform, 0 is the most mobile platform. In this study, static balance test, dynamic balance test in 2nd, 4th and 8th levels, and oscillation index test with open eyes have been used. The tests have been applied in upright posture on double leg. Double leg balance tests have been applied three times for duration of 30 seconds with a resting period of 10 seconds. Before the tests, the athletes have been subjected to a trial for 10 seconds in order to adapt to the static and dynamic balance tests and accept said tests. The participants have been asked not to move and speak during the test period. The tests of participants, who lost their balances, have been started again. The balance performances of the athletes have been determined as dynamic and static. Dynamic balance performances have been measured in three levels as good, moderate and low.

2.3. Statistical Analysis

The arithmetic means and standard deviations of data have been obtained in the statistical evaluation. The statistical evaluation of the study has been made by using SPSS 21.0 package program and descriptive statistics and Pearson Correlation tests have been applied. The significance level has been determined as $p<0.05$.

3. Results

Table 1: The Comparison of Quadriceps Femoris Muscular Force and Balance of the Athletes

Parameters (n=16)	M±SD	Total Work	Maximum	Relative	Average
Total Work	35501.23±18077.40	-			
Maximum	43.96±22.21	.976**	-		
Relative	453.75±223.99	.937**	.948**	-	
Average	35.46±18.05	1.000**	.976**	.938**	-
Oscillation Index	-.76±0.20	.405	.423	.375	.405
Dynamic Balance Level 1	1.72±1.06	.510*	.453	.294	.510*
Dynamic Balance Level 2	1.24±0.45	.008	.089	-.043	.008
Dynamic Balance Level 3	0.51±0.32	-.216	-.243	-.302	-.216

*p<0.05, ** p<0.01

It has been found out that the static balance performances and oscillation indexes of the athletes have not changed in accordance with femoris muscular force characteristics of the athletes ($p>0.05$); when dynamic balance performances are taken into consideration, it has been detected that as difficulty level increases, quadriceps femoris muscular force also affects the balance performance ($p<0.05$).

Table 2: The Comparison of Hamstring Muscular Force and Balance of the Athletes

Parameters (=16)	M±SD	Total Work	Maximum	Relative	Average
Total Work	25901.32±16456.29	-			
Maximum	28.25±15.97	.997**	-		
Relative	330.20±204.46	.965**	.964**	-	
Average	25.87±16.44	1.000**	.997**	.965**	-
Oscillation Index	-.7277±0.17	.992	.964	.800	.992
Dynamic Balance Level 1	3.86±2.29	.802	.764	.805	.802
Dynamic Balance Level 2	2.63±1.38	.746	.680	.742	.746
Dynamic Balance Level 3	1.69±0.40	.706	.802	.399	.706
Static Balance	0.62±0.37	.488	.521	.413	.488

** p<0.01

It has also been detected that double leg static and dynamic balance performances and oscillation indexes of the athletes have not changed in accordance with hamstring muscular force characteristics of the athletes.

4. Discussion

It has been found in our study that quadriceps femoris muscular force characteristics of the athletes affect the balance performances, and as balance difficulty level increases, quadriceps femoris muscular force becomes more importance; however, hamstring muscular force characteristics do not affect the balance performances (Tables 1 and 2) Mechanic antigravity and balance forming optimal stance, are provided by posture. Said function is performed by means of extensor antigravity muscles by providing rigidity for the joints and resisting the ground reaction force. The position of several body parts both determines the outer target positions and the organization of movements against said targets [9]. Although body control in upright posture requires the adjustment of several joints, it is thought that the muscles responsible for providing upright stance are abdominal group muscles and dorsal extensor muscles [10]. The muscles on the sole are calf muscle group, anterior leg muscles and posterior iliac muscles; and the muscles between shoulder and scapula are defined as postural muscles [11]. Hughes *et al.* [11] (1995) have indicated that ankle plantar flexors, knee flexors, hip flexors and shoulder flexors are of utmost importance among the postural muscles. Moreover, it is indicated that soleus has a vital importance in providing the postural control of medial gastrocnemius and tibialis anterior muscle [12]. Yaggie and McGregor [13] (2002) have indicated in their studies that plantar flexors and dorsal flexors are among the vital postures control muscles. Lin *et al.* [14] (2011) have investigated the temporal and spatial balance parameters of the individuals in their studies including 15 young men with an average age of 21-27 years. It has been found out in the study that quadriceps femoris muscular force affects the balance parameters. The main muscles such as neck muscles, hamstring muscles, soleus and supraspinalis muscles perform co-activations in said order during the gestures [15]. It has been found out in our study that hamstring muscular force does not any effect on the balance performance.

5. Conclusion

In conclusion, quadriceps femoris muscular force of the athletes affects the balance performance, and as balance difficulty level increases, quadriceps femoris muscular force maintains the balance. However, hamstring muscular force does not affect the balance performance. It is assumed that quadriceps femoris muscular force may be effective in the sports branches that put an emphasis on the balance, the muscle must be strengthened and should not be forced when it is damaged.

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