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Comparison of Knee Joint Proprioception and Balance between Soccer and Volleyball Players and Non-athletes

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Abstract

Background: In sports involving frequent twisting and jumping activities, proprioception and balance have fundamental roles in athletes' performance and functional ability of the non-athletic persons, too. Then, due to importance of proprioception for balance, postural control, and accuracy of motions the aim of this study was to compare the knee joint proprioception between soccer and volleyball players and non-athletic men. **Methods**: Ninety healthy male individuals were divided into three groups; including soccer players (mean ±SD: Age 21.9±2.0 yrs., Height 177.5±4.2 Cm, Weight 82.4±9.6 Kg), volleyball players (mean ±SD: Age 22.5±1.9 yrs., Height 187.7±4.2 Cm, Weight 82.4±9.6 Kg) and non-athletes (mean ±SD: Age 22.5±2.4 yrs., Height 175.5±5.0 Cm, Weight 70.9±11.0 Kg) (n=30 for each group). Active (AAR) and passive (PAR) angle reproduction error at an angular velocity of 60˚/s with target angle of 45˚ were measured using Biodex dynamometer. Stroke stand test was utilized to assess participants' balance. The data were analyzed using ANOVA and Tukey statistical tests ($P<0.05$). **Results:** The volleyball players (3.8˚) had less AAR than the soccer players (5.3˚) and non-athletic subjects (4.0˚) significantly ($P<0.05$). However, there were no statistical differences in PAR between the three groups ($P>0.05$). The volleyball players (38.0Sec) had better balance comparing to soccer players (32.8Sec) and non-athletes (27.0Sec) significantly ($P<0.05$).**Conclusions**: In conclusion, this study indicates that better knee joint proprioception and balance in volleyball players is attributed to repeated jumping motions in this sport. However, it is suggested to benefit jumping exercises in the rehabilitation protocols to improve proprioception and balance of athletes and non-athlete's persons with knee injuries.

Keywords: Proprioception; Balance; Volleyball; Soccer; Knee; Angle Reproduction Error.

1. Introduction

Proprioception is the awareness of physical condition that includes the sense of positioning, the sense of joint movement and the sense of force in the joint (1). Understanding the position of the knee joint is influenced by a number of sensorineural models, including vision and skin sensory information; but the most important sensory receptors are in the muscles, ligaments and capsules of the knee joint (2). According to Sharma (1999), proprioception is the perception of a member's position in space. This sensation is perceived through afferent messages transmitted from articular receptors and musculoskeletal receptors (3). Proprioception is essential to maintain joint strength. Weiler and Awiszus (2000) provide a definition of profundity, in which perception is considered a conscious act, and profundity is used when individuals are able to report direction when performing imposed movements. Therefore, the recognition of motion without understanding its direction is

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not accepted as a proprioception. Because these diagnoses are unclear. As a result, the threshold for unconscious perception must be lower than the specific conscious perception (4).

Proprioception is part of the reconstruction of sports injuries (5-7), because this sense is necessary to maintain posture, balance and coordination of joint movements. Therefore, a proprioception is essential in the correct and appropriate performance of physical skills. The specific involvement of the sense of depth is difficult to determine and decide on the sense of positioning, which is probably due to the body's ability to use a wide variety of sensory information received to determine the position and movement of the joint (8). Increasing muscle strength, improving joint posture and accuracy of proprioception, improving functional activities and reducing disability are the results of rehabilitation and exercise (9). Following joint injury, afferent information in an abnormal joint (damaged) may lead to a decrease in alpha motor neurons reception and a decrease in quadriceps muscle activity. The more severe the joint injury, the greater the reduction in activities that lead to muscle reactions (10).

The general mechanisms of knee injury in volleyball are more than jumping (12,11). Proper landing is a complex operation that requires a lot of coordination and requires dynamic muscle control and flexibility in the ankle and knee muscles (13,14). For older athletes, coordination and movement control are not fully available. A bad landing from a jump can cause injury. Biomechanical studies between landing patterns in injured and uninjured older volleyball players show that the peak of the ground reaction force is similar in both groups. In uninjured players there is a significant difference in the angle of flexion of the knee and thigh and also a significant difference in the extroverted activity of the quadriceps muscles during landing with injured athletes (15). Bullock et al. (2001) showed that the sense of position in the knee joint decreases with age, and research has shown that this decrease in the sense of position is seen in conditions without weight bearing (16). This study was designed to investigate the effect of age factor on the accuracy of knee position in both full and partial weight bearing conditions.

Awareness of the joint position and movement is essential for its proper functioning during exercise and daily life activities. Unconscious proprioception regulates the flow of muscle function and causes reflex stability. In contrast, muscle weakness, impaired proprioception, and decreased range of motion can compromise an athlete's ability to maintain a center of gravity within the body support level, or in other words, cause the athlete to lose balance (17, 18). Therefore, in order to perform sports activities, it is necessary to acquire effective strategies to maintain balance (20, 19). On the other hand, the knee is one of the most common joints injured in sports such as volleyball and football (27-21). Therefore, the aim of this study was to investigate and compare the proprioception of knee joint between two groups of soccer players and volleyball players and also to compare it with non-athletes.

2. Materials and Methods

Ninety healthy men were selected by convenience sampling. Subjects were divided into 3 groups of 30 people. The first group included professional volleyball players of the Premier League, the second group included soccer player of the national subgroup and the third group included non-athlete students. Table 1 shows the anthropometric information of the subjects.

Table 1. Anthropometric characteristics of the subjects

Group	**Weight (kg)**		**Height (cm)**		**Age (y)**	
	M*	**SD***	**M**	**SD**	**M**	**SD**
Volleyball player	82.4	9.6	187.7	6.0	22.5	1.9
Soccer player	68.8	8.4	177.5	4.2	21.9	2.0
Non-athletes	70.9	11.0	175.5	5.0	22.5	2.4

*SD = Standard Deviation, * M = Mean

Subject requirements for inclusion in this study include: Absence of musculoskeletal and orthopedic or neuromuscular disorders in the lower limb joints, 2 years history of continuous exercise for a group of athletes, and not engaging in sports at the beginner or professional level for the non-athlete group and being willing to participate in the study.

Angle reconstruction with closed eyes was used to measure the sense of position of the knee joint. After being placed on the Biodex device and tying its foot to the arm of the device, the subject reconstructed the desired angle 3 times and the device displayed the average error of 3 repetitions. To measure static balance, the standard test of standing on one leg (stork) was used, which was repeated 3 times and the best time was recorded for the subject. Saka's gauge was used to measure height and the height of the subject was recorded with an accuracy of 1 cm. To measure the weight of the subjects, a digital scale of Pand model was used and the measurements were recorded with an accuracy of 500 g.

To measure static balance, standing on one leg (stork) test was used. The subject stood on the right foot and placed the sole of the left foot on the inner side of the knee of the right foot and put his hand on the sides of the waist. With the command to move, the person would lift the heel of his right foot off the ground and stand on the toe, and at that moment the timer would start. The timer continued to operate as long as the subject was able to maintain balance. Time stopped when the heel of the raised heel came in contact with the ground, or the hand was detached from the sides of the waist, or when the subject did not raise his heel to the ground but leaned on the foot of his support. Took. This test was repeated 3 times and the best time of the subject was recorded. The values obtained were recorded in seconds (28).

The Biodex System 3 isokinetic dynamometer was used to measure the sense of position of the knee joint. The person sat on the seat of the device, the back of which was adjusted to about 70 degrees above the horizon. To prevent the effect of compressive forces, from the edge of the chair to the back of the knee, the distance between the edge of the chair and the humerus was considered to be 5 cm. The external femoral epicondyle was used as an anatomical marker to determine the position of the knee joint and was magically marked. Then, using seat belts, the subject was held firmly in place. The axis of rotation of the dynamometer lever arm was aligned with the axis of rotation of the knee and the lever arm cushion was placed on the lower third of the leg. Then, using the facilities installed on the control panel of the device and the available software, the range of motion of the lever of the device and as a result, the specific range of motion of each person was determined. After that, the proprioception protocol was given to the device. In this research, we determined the target angle of 45 degrees and the constant speed of 60 degrees and 3 repetitions for both active and inactive movements for the device. After all the above adjustments have been made, the person was asked to bring his / her foot to the extension position in active movement from flexion with open eyes to get acquainted with how to perform the test, so that the device can hold the movement at the target angle. Hold and immobilize the foot at the appropriate angle.

After the person became familiar with the angle of the target, the person was asked to bring their foot back into flexion. The subject's eyes were blindfolded at this stage. At this stage, the person was asked to reconstruct the target angle and move his leg from flexion to extension position, and whenever he thought he had reached the appropriate angle, using the key installed on the device near the subject's device. Kept him from moving. This test was repeated 3 times and after each test run by the subject, the device gave feedback to the person by re-executing the target angle while the eyes are open. The same test was performed to measure the sense of position of the knee joint in the inactive position, with the difference that the direction of movement of the joint was from extension to flexion. After the test, 3 numbers appeared on the screen of the device as an angle reconstruction error. These figures were related to the difference between the target angle and the angle that the subject reconstructed in 3 repetitions of the test, and one number as the average. These differences, which we used in our calculations the average number of differences (29).

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The present study was a comparative study due to the lack of a control group and the lack of pre-test. In descriptive studies, dispersion indices including standard deviation and center orientation indices including mean and median were used. SPSS software version 19 and one-way analysis of variance and Tukey post hoc test were used for inferential statistics.

3. Results

According to the measured factors and recorded in the data registration form and also considering the objectives and research questions, descriptive statistics and inferential statistics were used to conclude the data as needed. In the data exploration operation, which was initially performed on the data obtained from the subjects, extreme data were identified and it was found that one of the 90 subjects had a high difference in the angle of active reconstruction in terms of the record of active reconstruction. The way in which the curves of the variables are taken out of normal and the research results will be unrealistically affected. Therefore, it was decided to exclude this person from the calculations and replace him with another subject. In the static balance test, the maximum test limit was 60 seconds. That is, we set records above 60 seconds for the same 60 seconds, so that extreme data would not be biased in any of the research groups. Information about the mean and standard deviation of equilibrium variables and reconstruction error in both active and inactive modes is shown in Table 2.

Table 2 . Statistical description of equilibrium and reconstruction error

Variable	Group	M*	SD*
Balance (second)	Volleyball players	38	13.8
	Soccer player	32.8	15
	Non-athletes	27	19
Active reconstruction error (degree)	Volleyball players	3.8	1.8
	Soccer player	5.3	2.3
	Non-athletes	4	2.3
Inactive reconstruction error (degree)	Volleyball players	4.8	1.6
	Soccer player	6	2.7
	Non-athletes	5.6	2.6

*SD = Standard Deviation, * M = Mean

Table 3 shows the results of the inferential analysis of the balance data. According to the results, the balance difference between the three groups at the level of 0.05 is significant (P <0.05). Statistical analysis showed that the balance of volleyball players was significantly better than both groups (P <0.05), while other differences were not significant (P> 0.05) (Table 3). Table 4 summarizes the one-way analysis of variance for active reconstruction error factor.

Table 3. Summary of one-way analysis of variance of the balance factor

	Sum of squares	Degrees of freedom	Average square	F	p value
Intergroup	1887	2	943.5	3.64	0.3
Intragroup	22549.8	87	259.1		
Total	24436.8	89			

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Table 4 . Summary of one-way analysis of variance causing active reconstruction error

	Sum of squares	Degrees of freedom	Average square	F	p value
Intergroup	38..4	2	19.2	4.0	0.2
Intragroup	410.6	87	4.7		
Total	449.1	89			

Active reconstruction error was significantly different between the 3 groups (P <0.05). Using Tukey post hoc test, it was found that the active angle error of goal angle reconstruction in the group of volleyball players was significantly lower than the other two groups (P <0.05), however, other differences were not significant (P> 0.05) (Table 4).

The analysis of variance of the data related to the passive error reconstruction factor of the target angle is shown in Table 5.

Table 5.Summary of one-way analysis of variance causing passive reconstruction error

	Sum of squares	Degrees of freedom	F	p value
Intergroup	22.6	2	1.9	0.1
Intragroup	498.3	87		
Total	520.9	89		

4. Discussion

The present study is designed to answer the main question of whether there is a difference in the sense of knee joint position between soccer players, volleyball players and non-athletes. In this regard, three factors of static balance, active angle reconstruction error, and passive knee joint inactivation reconstruction error were measured and compared with three groups of male volleyball players, soccer players and non-athletes. The results showed that the balance of volleyball players is significantly better than that of soccer players and non-athletes. It was also found that the active reconstruction error of the volleyball team in the knee joint was significantly lower than the other two groups, while the inactive reconstruction error of the three groups was not significantly different from each other.

Regarding balance, the best balance record was 60 seconds, the worst record was 1.97 seconds, and the highest standard deviation in the static balance test was for the non-athlete group with a value of 18.99, and the lowest standard deviation was 13.84. He was a volleyball player. These results from the balance test seem logical because athletes generally have better balance. The difference between volleyball players and Soccer player was significant, mainly due to the fact that volleyball is a jumping discipline and, in a match, or training session, each player experiences jumping and landing many times and balances when landing. It motivates itself. By contacting the feet with the ground, the pressure receptors receive the distribution of weight at different points under the foot and transmit changes to the line perpendicular to the support surface to the central nervous system.

The results of Hobbes' (2008) study showed that dynamic balance is not significantly different between school, beginner and professional basketball players. He concluded that there is no relationship between dynamic balance and the ability of these athletes (30). The results of the Hobbes study are inconsistent with the present study, as our study found that volleyball players who were more capable than non-athletes also had better static balance. The researchers say that the reason for this difference could be related to the difference in the subject's sport as well as the and balances when landing. It motivates itself. evaluated factor (dynamic balance versus static balance). On the

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other hand, the results of the study of Parker et al. (2007) are consistent with the findings of the present study. After evaluating balance control while walking athletes and non-athletes with dizziness and comparing it with healthy athletes and non-athletes, the researchers found that participating in a high-pressure exercise activity could have beneficial effects on balance control. (31). The results of the present study are consistent with the findings of Hrisomalis et al. (2006). The researchers stated that the level of static balance in Soccer player is low, although it has no significant relationship with the dynamic balance and performance level of these athletes (32).

Regarding the error of changing the angle of the knee in the active state, the lowest error was related to the group of volleyball players and the highest error was related to the footballers, which was statistically significant, while both groups were not different from the non-athlete group. Did not show significance. In the test, the error of changing the angle of the knee angle in the active state was 9.3 degrees and the lowest error was 1 degree and the highest standard deviation in the group of footballers with a value of 2.3 and the lowest standard deviation is related to the group of volleyball players with a value. It was 1.8. In the passive knee angle change error test, the highest error was 10 degrees and the lowest error was 0.7, and the highest standard deviation in the football group was 2.7 and the lowest standard deviation was in the volleyball group with 1.6. In the case of active error, it makes sense that the least error was related to the volleyball team, because as mentioned earlier, volleyball is a jumping sport and a volleyball player jumps and lands many times during a match or training session. During the jump as well as the descent from the jump, the spindles and limbs of the forearm are strongly stimulated and their flowers rise, and this can be the reason for the superiority of volleyball players in this test (33).

As we know, volleyball is a sport with jumping and a volleyball player experience jumping many times in a training session or game, and during landing due to the weight he bears on his knees and eccentric contractions on the quadriceps muscle. The stimulus is applied to the deep sensory receptors, and by stimulating these receptors over time, the sensitivity of these receptors increases and leads to a stronger sense of position in this group of athletes. The same is true of static balance. Because the volleyball team had the highest average static balance and this difference was statistically significant with the non-athlete group. As mentioned earlier, the posture control system uses sensory information about movement and posture from peripheral sensory receptors (such as muscle spindles, Golgi vein receptors, articular afferents, and dermal receptors) that improve the sense of joint position. The sensitivity of these receptors and their ability to respond to stimuli is doubled (34).

On the other hand, researchers interpret the lower level of depth of feeling in Soccer player than the other two groups due to the relative looseness of the ligaments around the knee. The sport of football has intense rotational and torsional movements, so that it can cause loosening of ligaments or mild tears in the long run. Research confirms this fact, as it has been proven that the knee joint is the most common joint to be injured in football (37-35). Although the Soccer player in this study did not have any macro traumatic injuries to the knee joint, the stress on the knee ligaments was noticeable; this is caused by repeated twisting movements, causing slight ligament rupture or rupture that is not clearly visible. However, it seems that such ligament deformities can impair and reduce the efficiency of deep receptors and thus reduce the level of profundity. It seems that more active and inactive reconstruction errors of the target angle in Soccer player than non-athletes can be interpreted based on the above. Researchers, on the other hand, believe that another possible reason for the difference in the performance of Soccer player and volleyball players is their level of sports activity; because the subjects of the volleyball group were all members of the Premier League teams, while the subjects of the Soccer group were all members of the national subgroup teams. Therefore, it is possible that the higher skills of the volleyball players participating in this study compared to the Soccer players are due to the higher proprioception level of the volleyball players.

5. Conclusion

It can be concluded that doing exercises that involve jumping movements, for both athletes and non-athletes, can increase the level of profound proprioception function and consequently improve balance, which ultimately prevents injury or at least minimizes the risk.

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Conflicts of Interest

The authors report no conflict of interest

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