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Research Article / Araştırma Makalesi

Does secondary cognitive task affect knee force production sense in young male soccer players?

Genç erkek futbolcularda ikincil bilişsel görev diz eklemi kuvvet üretme duyusunu etkiler mi?

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ABSTRACT

Objective: The aim of the present study is to compare the knee force production sense error (KFPSE) of young soccer players under single and dual-task conditions.

Materials and Methods: Twenty-four young male soccer players with a soccer license participated in this study. Knee force production sense (KFPS) was evaluated using a biofeedback device. In order to compare the KFPSE first, the bilateral KFPS of the participants was evaluated. Then the same assessment was performed concurrently with a cognitive dual task (five countdowns from 200).

Results: The results revealed that, compared with the single-task condition, players had higher absolute error under the dual-task condition for both extremities ($p<0.05$).

Conclusion: Secondary cognitive task may be a possible critical factor reducing the accuracy of the force (re)production sense. A secondary cognitive task may adversely affect the KFPS.

Keywords: *Force production sense, male soccer players, secondary cognitive task*

ÖZ

Amaç: Genç futbolcuların tekli ve ikili görev koşulları altında diz eklemi kuvvet üretme duyusu hata skorlarının karşılaştırılmasıdır.

Gereç ve Yöntem: Çalışmaya, futbol lisansına sahip 24 genç erkek futbolcu katıldı. Katılımcıların kuvvet üretme duyu ölçümleri basınçlı biofeedback cihazı ile yapıldı. Katılımcıların tekli ve ikili görev hata skorlarını karşılaştırmak için ilk olarak katılımcıların bilateral diz eklemi kuvvet üretme duyuları değerlendirildi. Ardından aynı değerlendirme eşzamanlı bir bilişsel görev ile (200'den beşer geri sayma) gerçekleştirildi.

Bulgular: İki ölçüm arasındaki kuvvet üretme duyu hata skorları karşılaştırıldığında, ikili görev eşliğinde ortaya çıkan kuvvet üretme duyu hata skorlarının her iki ekstremitede de daha yüksek olduğu belirlendi ($p<0.05$).

Sonuç: Bilişsel görevin kuvvet hatırlama görevinin doğruluğunu azaltan olası kritik bir faktör olabileceği, ikincil bir bilişsel görevin diz eklemi kuvvet üretme duyusunu olumsuz etkileyebileceği sonucuna varıldı.

Anahtar Sözcükler: *Kuvvet üretme duyusu, erkek futbolcular, ikincil kognitif görev*

INTRODUCTION

Soccer is a sport characterized by intense neuromuscular demands, involving acceleration, changes in direction, deceleration and struggle. Soccer players are exposed to both cognitive and motor difficulties at the same time during the match and training. Performance in soccer depends on physical fitness, and tactical, technical and mental components. Because of this complex structure, which influences soccer player performance, soccer players should have sufficient equipment and skills in many parameters instead of being at a high level in a single parameter (1).

Joint position sense, kinesthesia (active and passive motion perception), and sense of force (tension, resistance, or weight) are components of proprioception (2). The sense of force is defined as a component of proprioception related to the feeling of tension, mainly derived from muscle spindles and Golgi tendon organs. Force sense error is considered as one indicator of proprioceptive loss (3). Proprioception is important for performance with tasks such as maintaining balance, maintaining lower extremity functions, accuracy of skills, and protecting the joint from excessive movements (4). In addition, good proprioceptive ability ensures that the components of the musculoskeletal system remain in

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balance, and it is important for high performance in soccer players by maintaining dynamic joint stability (5,6). Proprioception deficit has an important effect on the occurrence of injuries during sports activities because of the effects of proprioception on motor control (7).

Mental and emotional components affect the physical and technical aspects of performance in soccer. Team sports, such as soccer, require players to simultaneously process more than one source of information while displaying their skills (8). In soccer, the ability of players to share the focus of attention among different cues in the environment (for example, the ball, opponents and teammates) is extremely important for successful decision making. In addition, players must simultaneously perform various motor actions, such as running, passing and dribbling, which are defined by dual-task (9). During the match, the player has to decide and perform the best action (passing, dribbling, shooting, misleading the opponent, avoiding incoming external forces, preparing positions for his friends, positioning on the field, and viewpoint, etc.) as soon as possible. Soccer players who display superior performance in processes related to such dual-task performances also maximize their performance by making the right moves at the right time and the right place. Having a high level of dual task skill increases the physical performance of the soccer player (10).

Investigators studied the dual-task paradigm to investigate the effects of the allocation of attention and other cognitive resources on performing both tasks right (11). Previous studies in different areas investigated the effects of dual-task on young healthy individuals (12), children (13,14), the elderly (15), individuals with Parkinson's and Alzheimer's diseases(16), and individuals with brain damage (17). Researchers reported a decrease in dual-task performance in both healthy and individuals with health problems (18).

Although previous studies on dual-task effects in sport exist, to our knowledge no study investigated the effect of dual-task on KFPS in soccer players. We carried out our study with the hypothesis that the secondary cognitive task may affect the force production sense in soccer players who are under a cognitive load while performing many motor tasks during the match. The present study was planned to evaluate the KFPS under a cognitive dual-task and to investigate whether there is any change in the KFPSE.

MATERIAL and METHODS

The study was approved by the Ethics committee of Ankara Yıldırım Beyazıt University, dated 09.07.2020 with decision number 60.

Participants

The present study was conducted with twenty-four young male soccer players between the ages of 16-19 years. Study evaluation methods were explained to those participating in the study, and their informed consent was obtained. Women, subjects with orthopedic or neurological problems, history of injury or surgery, and disease affecting balance and performance in the last six months were excluded. Post-hoc power analysis was performed with the G*Power (3.1.9.4) software, and the power of the research was found to be 97.5% with a 5% alpha margin of error with the two-tailed post-hoc power analysis for dependent variables of the dominant side.

Protocol

KFPS was evaluated due to the importance of the knee joint for locomotor and postural control, and knee is a frequently injured joint in soccer players (19). The evaluation was performed on both dominant and nondominant knee joints. A pressure biofeedback device (StabilizerTM, Chattanooga Group Inc., Chattanooga, TN) was used in the evaluation of KFPS (20). Tactile stimulation, anesthetics, fatigue and cold are the factors that can negatively affect KFPS (21). Necessary precautions have also been taken to minimize the effects of fatigue, tactile stimulation, heat and cold, which are thought to affect KFPS negatively. Evaluations were made at room temperature in a quiet environment, before training, and by wearing shorts without tactile stimulation. All evaluations were made in the morning before the training, at the same time, and under the same conditions. In addition, all athletes were evaluated by wearing shorts to prevent the tactile stimulus effect, which was reported to negatively affect the KFPS. In this way, fatigue and tactile stimulations, which are reported to negatively affect KFPS, are minimized.

The players sat with their knees fully extended and their ankles free in slight plantar flexion (extend sitting). At the beginning of the test, the pressure unit was placed under the knee joint and the air pressure was set to 20 mm Hg with no muscle contraction (Figure 1a). The players were asked to press their knees towards the bed to make maximum voluntary isometric contraction (MVC) of the quadriceps femoris muscle, and to maintain this position for five seconds (Figure 1b). The highest value on the screen of the device during the MVC was recorded in mm Hg, and 50% of the MVC was recorded to be used to evaluate the KFPS.

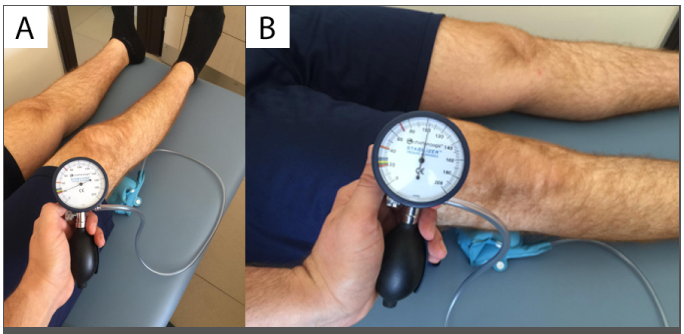

Figure 1. a. Extend sitting position and the air pressure unit positioning; b. The air pressure unit value during maximum quadriceps muscle contraction.

Then, the players were asked to contract the quadriceps femoris muscle isometrically with their eyes closed until reaching 50% of their MVC value, using only verbal feedback from the researcher. The players were told to hold this position for 5 s. and then to relax. The players were instructed to exert maximal effort for the entire duration of the three trials. The rest periods between the trials was 30 s.

After three trials, the test protocol was begun. When the players felt they had reached 50% VMC, they were asked to say "ok" to the researcher. The value that the players said ok and maintained for 5 s was recorded. The difference between this recorded value and 50% of the MVC was calculated, and the result was recorded as the absolute difference. These procedures were repeated three times and the average of absolute values of the differences from the three measurements was accepted as the test result. After the players had a rest, they were asked to perform a simultaneous cognitive dual-task (counting down five by five from 200), while the same procedure was being performed. The procedure was repeated three times and the average of the three measurements was considered as the test result. High deviation scores reveal poor KFPS, while low deviation scores show good KFPS (20).

Statistical Analysis

Statistical analysis was performed by using "Turcosa Analytical Cloud Software (Turcosa Ltd. Co, Turkey)". The variables were investigated using Kolmogorov-Smirnov/Shapiro-Wilks tests to determine whether or not they are normally distributed. Mean ± standard deviations and minimum-maximum values were used for descriptive analyses. Paired Student's t-test was used to compare the measurements in two conditions (single-task and dual-task) for KFPSE. A $p<0.05$ was considered to reveal a statistically significant result.

RESULTS

The study was completed with 24 male soccer players. The characteristics of the players, the sport age, and the players' weekly training volume are provided in Table 1. KFPSE values of the soccer players were higher in both extremities under a cognitive simultaneous secondary task, and a secondary cognitive task negatively affected the KFPS ($p<0.05$) (Table 2).

Table 1. Descriptive data of the players (n=24)

Parameters	X̄±SD	Minimum-Maximum
Age (yrs)	16.9 ± 1.03	16.0-19.0
BMI (kg/m²)	22.0 ± 3.1	17.7-29.8
Sports age (yrs)	4.25 ± 0.84	3.00-6.00
Training volume (hrs/wk)	6	

BMI: body mass index; X±SD: mean ± standard deviation

Table 2. Comparison of dominant and non-dominant extremity single and dual task KFPS of soccer players

	Single task	Dual task	t	p
Dominant KFPSE (mm Hg)	7.87 ± 4.02	11.71 ± 5.18	-4.10	<0.001
Nondominant KFPSE (mm Hg)	8.31 ± 3.83	11.71 ± 6.75	-2.81	0.010

Figures as mean ± standard deviation

DISCUSSION

In the present study, which was performed to investigate the effect of a secondary cognitive task on KFPS in young male soccer players, it was determined that a secondary cognitive task added to the motor task negatively affected KFPS. To our knowledge, this is the first study to demonstrate that the effects of a secondary cognitive task on KFPS in young male soccer players. A systematic review in the literature reveals that secondary task impairs performance in different populations, or individuals with different pathologies (18).

According to the results of the study, the fact that the KFPSE values of the soccer players are high during the dual-task, despite the fact that they are exposed to dual-task processes, and trained in this way many times during training, and in matches; it is important to reorganize the training programs of the players with more cognitive load.

The findings in the present study are in line with established cognitive theories, which argue that dual-task situations overstrain cognitive abilities, resulting in motor performance declines. Goble et al. (22) has reported that performing a dual-task leads to impairment in sensory-motor performance due to a limitation in the resources allocated simultaneously to cope with both tasks. Laurin and Finez (23) observed that the higher the difficulty level of secondary cognitive tasks, the higher the performance impairment. Soccer players were asked to count backward from 200 five by five, and in parallel with the work of Laurin and Finez, an increase in KFPS values was detected in the dual-task in the present study. The reason for the increase of the KFPS

value under dual-tasking condition is that the encoding of the proprioceptive force sense by the brain is adversely affected by the allocation of limited attention resources during the dual-tasking. Laurin and Finez (23) reported results in parallel with our study, suggesting that cognitive tasks generally require most of the attention resources, overload working memory, and therefore reduce cognitive and motor performance.

One reason for the high KFPSE value with a cognitive dual-task may be the low mean age and sports age of the soccer players in the present study. Beilock et al. (24) reported that by automating motor tasks, expert athletes could focus their attention more on the cognitive task and complete the process with less motor function loss during the dual task. The previous study has shown that with increasing practice and experience, motor task performance became more automated, and therefore required less attention (8). In view of these findings, the effect of experience on KFPS in a cognitive dual-task can be determined with evaluations in amateur and expert soccer players in different age groups.

An increase in KFPSE values in dual-task is also extremely important in terms of injury and performance according topresent findings. Previous studies have reported that poor proprioception is one of the main factors of knee injuries (25-27). Deursen (28) suggested that a decrease in lower extremity proprioception ability causes injuries. Zazulak et al. (29)reported that the probability of predicting injury is associated with a high level of proprioceptive loss. In addition, Allison et al. (30) reported that inability to produce balanced force increases the risk of injury, and that the sense of proprioceptive force plays an important role in maintaining functional joint stability. The results obtained from this study reveal that the addition of a cognitive task during motor tasks in soccer players negatively affects proprioception. Considering that the deterioration in proprioception also increases the risk of injury, we think that training aiming at increasing the performance of various cognitive dual tasks, and motor task of soccer players are also important in terms of protection from injury.

Some limitations exist related to present study. The fact that only young male soccer players were included in this study, limits the generalizing ability of our results. More comprehensive results can be achieved with studies to be carried out in different age groups and expert soccer players. This study examined the effect of only one cognitive task. The effects of different tasks can be revealed with studies to be carried out with various motor or cognitive dual tasks with differing difficulties.

In conclusion, performing a cognitive dual-task in young male soccer players negatively affects KFPS compared with the single-task. We think that an increase in the performance of soccer players and a decrease in the risk of injury can be achieved by arranging training programs that include more cognitive load.

Ethics Committee Approval

The approval for this study was obtained from Clinical Research Ethics Board of Ankara Yıldırım Beyazıt University (Approval number: 60, Date: 09.07.2020).

Conflict of Interest / Çıkar Çatışması

The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

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Author Contributions / Yazar Katkıları

Concept ED,MÖ; Design All authors; Supervision ED; Materials MÖ; Data Collection and/or Processing MÖ; Analysis and Interpretation ED,MÖ; Literature Review ED,MÖ; Wiriting Manuscript MÖ; Critical Reviews ED

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