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Vitamin D Status in Soccer Players with Skeletal Muscle Injury

Kas Yaralanması Olan Futbolcularda Serum Vitamin D Düzeyleri

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ABSTRACT

Objectives: The main objective of the present study was to evaluate the prevalence of vitamin D deficiency and insufficiency in a group of soccer players, and to investigate the relationship between 25-hydroxyvitamin D [25(OH)D] concentrations, and muscle strain injuries and time taken to return to play.

Material and Methods: Serum vitamin D levels were measured in a sample of 56 male soccer players (skeletal muscle injury group, n=36; healthy control group, n=20), homogeneous in terms of factors influencing serum 25(OH)D concentration, from the capital city of Turkey, Ankara (Latitude: 39°57'N), between January-April 2017. Skeletal muscle injury was confirmed with magnetic resonance imaging (MRI), and history of muscle injury was documented as part of routine care. The relation between serum 25(OH)D levels and muscle strain injury, severity of injury, and the correlation between serum 25(OH)D levels and time taken to play was evaluated.

Results: High prevalence of vitamin D insufficiency among participants was detected. The average 25(OH)D level of 56 athletes was 15.9 ± 8.1 ng/ml (range 5.3 to 38.6 ng/ml). The distribution of vitamin D level results was as follows: deficient (<10.0 ng/ml) in 13 subjects (23.2%), insufficient (10.0-24.9 ng/ml) in 37 subjects (66.1%), and adequate (≥25.0 ng/ml) in six subjects (10.7%). The difference in 25(OH) D levels between skeletal muscle injury group and the controls (16.2 ± 8.4 ng/ml vs 15.3 ± 7.8 ng/ml, respectively, p=0.98) was not significant. In addition, no correlation was found between 25(OH) D level and time taken to play (r=0.175, p=0.31).

Conclusion: Low vitamin D levels were common among athletes and vitamin D inadequency did not seem to be associated with sustaining muscle strain injury.

Keywords: Muscle injury, vitamin D, 25(OH)D, soccer player

ÖZ

Amaç: Bu çalışmanın amacı futbolcularda D vitamini yetersizliği ile eksikliğini değerlendirmek ve 25-hidroksi vitamin D [25(OH)D] düzeyinin kas yaralanmaları ve spora dönüş zamanına etkisini araştırmaktır.

Gereç ve Yöntemler: Çalışmaya Ankara'da yaşayan (Enlem: 39°57'N) 56 erkek futbolcu (iskelet kası yaralanması grubu, n=36; sağlıklı kontrol grup, n=20) dâhil edilmiş olup, serum D vitamini düzeyleri 2017 yılı Ocak-Nisan ayları arasında ölçüldü. İskelet kası yaralanmaları tanısı manyetik rezonans görüntüleme (MRG) ile konulmuş olup, sporculardan geçirilmiş kas yaralanmaları öyküsü bilgileri alındı. Buna göre serum 25(OH)D düzeyleri ile kas yaralanmaları arasındaki ilişki ve spora dönüş zamanlarındaki farklılıklar karşılaştırıldı.

Bulgular: Çalışmaya dahil edilen sporcularda yüksek oranda D vitamini yetmezliği gözlendi. Elli altı sporcunun ortalama 25(OH)D düzeyi 15.9 ± 8.1 ng/ml (5.3- 38.6 ng/ml aralığında) idi. D vitamini düzeyleri 13 sporcuda (23.2%) eksik (<10.0 ng/ml), 37

sporcuda (66.1%) yetersiz (10.0-24.9 ng/ml) ve altı sporcuda (10.7%) yeterli (≥25.0 ng/ml) düzeyde bulundu. İskelet kası yaralanması olan grupla sağlıklı kontrol grubu arasında 25(OH) D düzeyleri açısından anlamlı farklılık gözlenmedi (sırasıyla 16.2 ± 8.4 ve 15.3 ± 7.8 ng/ml, p=0.98). Ek olarak 25(OH) D düzeyi ile sporcuların spora dönüş zamanı arasında korelasyon gözlenmedi (r=0.175, p=0.31).

Sonuç: Sporcularda D vitamini yetmezliği sık görülmekte olup, D vitamini yetmezliği ile kas yaralanmaları arasında ilişki saptanmamıştır.

Anahtar Sözcükler: Kas yaralanması, D vitamini, 25(OH)D, futbolcu

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INTRODUCTION

Muscle injuries are the most common complaints in sports medicine practice and non-contact muscle strain injuries are usually seen in sporting events in which high speed sprinting, jumping, kicking and rapid changes of direction are frequently performed, especially in soccer (1). These kind of injuries account for more than one-third of all time-loss soccer injuries and cause significant lost playing time (1-3). Many injury risk factors have been proposed for muscle strain injuries, including previous history of muscle injury, older age, limited flexibility, strength deficit or imbalance, insufficient warm-up, and fatigue (4). Therefore, in order to develop injury prevention strategies, definition of predisposing risk factors for these injuries are essential (5).

In order to maintain musculoskeletal health as well as the immune system, Vitamin D is required (6). In spite of the fact that literature provides no proof that sportsmen require a higher daily intake than the general population, the increased sick days, decreased muscle performance and a susceptibility to stress fractures has been linked to 25-hydroxyvitamin D [25(OH)D] deficiency in athletes (6). The strong correlation was reported between vitamin D adequacy and most favorable muscle function (7). The increased vitamin D levels can minimize inflammation and pain. Due to increased muscle protein synthesis and muscle strength, higher level of vitamin D can also reduce myopathy (7).

Despite studies that investigated vitamin D status in athletes, there is a lack of knowledge about vitamin D deficiency and its relation with skeletal muscle injury. In a published abstract, where vitamin D levels and skeletal muscle injury presence were assessed from 89 professional American football players, it was noticed that players who sustained at least one muscle injury throughout the preceding season displayed significantly lower vitamin D levels than the players that suffered no muscle injury during the same period (8). However, there is no supporting data for this study, and the lack of knowledge about any serum biochemical markers that may be related to muscle strain etiology.

The present study was conducted to evaluate whether 25(OH)D concentrations in soccer players are linked to skeletal muscle injury and time taken to return to play. In this case, it would be concluded that prevention of muscle injury and healing are possibly influenced by sufficient circulation of vitamin D.

MATERIAL and METHODS

Fifty-six male Caucasian soccer players with a mean age of 29.4 ± 8.9 years (range, 18-40 years) were included in our study between January 2017 and April 2017. All subjects were involved in soccer as an outdoor sport, in the capital city of Turkey, Ankara (Latitude: 39°57'N). Athletes who applied to the sports medicine department with a complaint of muscle injury in the last 72 hours were evaluated, and blood samples were taken immediately from the antecubital vein (9). Thirty-six patients and 20 control participants were eligible in accordance with the inclusion criteria, and were included in the study after obtaining informed consent form.

After obtaining anthropometric values, athletes were asked to complete a questionnaire, which included questions on previous muscle injuries. Age-matched controls (n=20) were also asked to complete the same sports injury history questionnaire. In order to estimate energy intake and to analyse daily consumption of calcium and vitamin D, all subjects completed a detailed food frequency questionnaire and dietary records for four days (10). None of the participants reported to use vitamin D supplementation. Blood samples for analysis of vitamin D were collected after physical examination, and the filled form was obtained. Diagnosis of muscle strain was confirmed by magnetic resonance imaging (MRI). Muscle injuries were graded according to the Mueller-Wohlfahrt Classification by a radiologist who is expert on muskuloskeletal injuries (9).

Serum levels of the following parameters were determined: complete blood count (CBC), 25(OH)D3, calcium (Ca), phosphate (P), parathormone (PTH), vitamin E, vitamin B12, serum iron parameters (iron, transferrin, ferritin, total iron binding capacity), acute phase reactants (erythrocyte sedimentation rate, C-reactive protein), muscle damage parameters (creatine kinase, uric acid, lactate dehydrogenase and aspartate aminotransferase) and myoglobin. Serum was separated by centrifugation and 25(OH)D levels were assessed by high performance liquid chromatography-tandem mass spectrometry (LC-MS/MS) using Shimadzu LCMS-8040 (Shimadzu Corp., Japan), according to standardizied laboratory operating procedures. Vitamin D levels were considered as deficient (<10.0 ng/ml), insufficient (10.0-24.9 ng/ml), and adequate (>25.0 ng/ml). The local ethics committee of Hacettepe University Human Ethics Committee (Decision number: GO 17/398) approved the study.

Statistical Analysis

SPSS software version 21 (SPSS, Chicago, IL, United States) was used to analyse statistical data. Normality of variable distribution was investigated using the Kolmogorov-Smirnov test. Descriptive analyses were expressed as means ± standart deviations (SD), medians (interquartile range (IQR) or range) and percentages (%), as appropriate. In order to compare normally and non-normally distributed variables, Student's *t*-test and the Mann-Whitney *U* test were used respectively. For the evaluation of the correlation between return to play time and serum 25(OH)D levels, Spearman's rank correlation coefficient was used. The level of significance was set at $p<0.05$.

Table 1. Comparative characteristics of the study groups

Parameter	Total (n=56)	Muscle Injury Group (n=36)	Control Group (n=20)	p
Age (yr)	28.8 ± 7.5	29.6 ± 8.0	27.3 ± 6.6	0.28
Height (cm)	179.0 ± 7.1	178.9 ± 7.1	179.3 ± 7.3	0.84
Weight (kg)	79.0 ± 10.6	79.0 ± 11.8	78.9 ± 8.3	0.97
BMI (kg/m^2)	24.7 ± 2.8	24.7 ± 2.8	24.6 ± 2.9	0.91
25(OH)D (ng/ml)	15.9 ± 8.1	16.2 ± 8.4	15.3 ± 7.8	0.98

25(OH)D: 25-hydroxy vitamin D

RESULTS

A total of 56 male football players were included in this study. Thirty-six patients had a muscle injury during the study (mean age of 29.6 ± 8.0 years), and 20 healthy controls did not (mean age of 27.3 ± 6.6 years). Comparative characteristics were presented in Table 1. More than half of the subjects (n=30, 53.5%) were playing football at recreational level, whereas the rest were professional or semi-professional football players. No significant difference in age, height, weight and BMI between skeletal muscle injury group and the healthy controls was noticed. There was no significant difference between groups for any biochemical markers (serum phosphorus, calcium, vitamin B12, ferritin and vitamin E levels). Skeletal muscle injuries were located as

following: hamstring (n=15, 41.6%), quadriceps (n=10, 27.8%), gastrocnemius (n=6, 16.7%) and adductors (n=5, 13.9%). There were high prevalences of vitamin D deficiency or insufficiency among participants. The average serum 25(OH) vitamin D level of 56 athletes was 15.9 ± 8.1 (range 5.3 to 38.6) ng/ml. Vitamin D levels were deficient (<10.0 ng/ml) in 13 subjects (23.2%), insufficient (10.0-24.9 ng/ml) in 37 subjects (66.1%), and adequate (>25.0 ng/ml) in six subjects (10.7%) (Table 2). Mean 25(OH)D level among players who did suffer a muscle injury was 16.2 ± 8.4 ng/ml, while 15.3 ± 7.8 ng/ml among controls, and there was no significant difference between groups (p=0.98).

Table 2. Descriptive statistics among study population with deficient, insufficient, and adequate levels of serum 25(OH)D

		Vitamin D Status Category		
	Total	**Deficient** (<10.0 ng/ml)	**Insufficient** (10.0-24.9 ng/ml)	**Adequate** (>25.0 ng/ml)
N (%)	56	13 (23.2)	37 (66.1)	6 (10.7)
25(OH) D (ng/ml)	15.9 ± 8.1	7.5 ± 1.3	16.8 ± 4.1	28.6 ± 0.2

25(OH)D: 25-hydroxy vitamin D

Table 3. Serum 25(OH)D levels according to recurrence and grade of injury

n=36	**25(OH)D** (ng/ml)	**p**
Patients with skeletal muscle injury		
Single (n=17)	15.8 ± 5.9	0.72
Recurrent (n=19)	16.6 ± 5.4	
Grade of skeletal muscle injury		
Grade 3a (n=19)	16.5 ± 6.2	0.86
Grade 3b (n=17)	15.9 ± 4.9	

25(OH)D: 25-hydroxy vitamin D

Athletes who have had muscle injury were grouped according to muscle injury degree. Mean serum 25-OH vitamin D level of subjects with grade 3a muscle injury (n=19) was 16.5 ± 6.2 ng/ml, while the subjects with grade 3b muscle injury (n= 17) had a level of 15.9 ± 4.9 ng/ml . Therefore, no significant difference was noticed between severity of the muscle injury and 25(OH)D level (p=0.86) (Table 3).

Additionally, the patients who had skeletal muscle injury (n=36) were divided into two groups: with no previous muscle injury history (n=17) and recurrent muscle injury (n=19). The mean serum 25(OH)D level was 15.8 ± 5.9 ng/ml in the first group, and 16.6 ± 5.4 ng/ml in the second, and there was no significant difference between them (p=0.72) (Table 3).

No correlation was found between serum 25(OH)D level and time taken to return to play (r=0.18, p=0.31). The median (IQR) return to play time was significantly higher in patients with grade 3b muscle injury as compared to patients with grade 3a muscle injury (25 (15) days vs 14 (9) days, p<0.001), as expected.

According to the nutrition intake assesment questionnaire, mean dietary vitamin D intake was noticed to be 221 ± 67 IU/day, and mean dietary calcium intake was 825 ± 242 mg/day in all participants. Vitamin D and calcium intake was not significantly different in participants comparing injury group and controls (p=0.56 and p=0.38, respectively). Furthermore, when all of the participants were divided into two groups as BMI<25 (n=35) or≥25 (n=21), there was no

difference in serum 25(OH)D levels between them (p=0.90), either.

DISCUSSION

The frequency of muscle injuries in athletic population is noticeable, but its correlation with serum vitamin D concentration is still uncertain. This is the first study to show the level of vitamin D status as risk for muscle injury among soccer players. In contrast to the unique data in the literature in 2011 by Shindle et al, we determined no significant difference for serum 25(OH) D level between soccer players who had a skeletal muscle injury and control subjects (8). This unpublished data examined vitamin D levels of 89 National Football League players, and reported that the players with significantly lower vitamin D levels were more prone to musculoskeletal injuries (mean 19.9 ng/ml vs. mean 24.7 ng/ml; p=0.04) (8). In a pilot study from Australia, in which 16 male ballet dancers were examined; Ducher et al. reported similar to our findings, no significant difference in the frequency of reported musculoskeletal injuries among subjects with vitamin D deficiency or insufficiency, and those with normal vitamin D status (11). They recommended further investigations in larger samples to see whether low levels of vitamin D place participants at higher risk for musculoskeletal injuries.

Additionally, low serum vitamin D levels were shown not to be related with rotator cuff tear size or extent of retraction (12). Similarly, we found no correlation with severity of muscle injury and serum vitamin D level. Despite claims about slower muscle recovery and function being caused by low levels of vitamin D, present findings revealed that there is no relation between serum vitamin D level and time taken to return to play (13). Some molecular effects of vitamin D within the muscle cell, such as regulatory effects on calcium flux, mineral homeostasis or signaling pathways controlling protein anabolism, have been proved (14). However, it is still unclear that how vitamin D contributes to the muscle injury pathway. Muscle weakness is one of the well known risk factors of skeletal muscle injury (15). Vitamin D receptors existing in the skeletal muscle were attributed a relation with muscle weakness in individuals who are severely deficient, and further genomic studies should be designed to present the potential impact of vitamin D deficiency on the risk of muscle injuries in athletes (16,17).

Vitamin D deficiency and insufficiency is now accepted as a major public-health problem worldwide in the young, active and healthy populace including athletes (6). Vitamin D status was shown to be strongly associated with outdoor training time (sun exposure during peak sunlight), color of the skin (ethnicity) and geographic location (18,19). Significantly increased risk was reported for winter and spring seasons in higher latitudes and for indoor sport activities (18,19). It has been recently reported that athletes display high prevalence of vitamin D insufficiency and deficiency (18). Furthermore, this was outlined to be the most frequent medical condition in professional football players in periodic health evaluation (20).

Farrokhyar et al. reported in a systematic review that 56% of 2313 athletes had vitamin D insufficiency, which significantly varied by geographical location (6). These results were consistent with our present findings in Turkey in wintertime. Suprisingly, 91% of athletes in Middle Eastern countries were reported to have vitamin D deficiency (serum concentration <20 ng/ml) during summer and fall (21,22). Several factors such as sunlight exposure, changes in vitamin D metabolism, smaller body mass, lack of dietary vitamin D consumption, ethnic beliefs, or malabsorption were shown to be associated with vitamin D deficiency in the Middle East (22,23). Despite the fact that dietary studies revealed unsatisfactory vitamin D dietary intake for athletes, the most probable cause for low status is inadequate synthesis due to lack of sun exposure. Despite the outdoor nature of soccer and adequate dietary vitamin D consumption in participants in this study, they were living at high latitude, and in a city with lack of sun exposure in wintertime. This may explain the high prevelance (94.6%) of vitamin D insufficiency and deficiency in our subjects. Similarly, normal levels of 25(OH)D were

observed in 50% of Polish professional football players after the summer period, but only in 16.7% of the players after the winter period (24). Another study revealed that 25(OH)D concentrations of collegiate athletes decreased in wintertime, and significantly correlated with multivitamin intake in winter (25). Excess body fat or obesity were shown to be associated with poor vitamin D status in athletes (26,27). The reason for this association is still unclear, but it was supposed to be caused by either sequestration of fat-soluble vitamin within the adipose tissue, or the effect of volume dilution related to obese individuals' larger body size (26). However, our results were inconsistent with these studies, and showed that BMI had no relation with vitamin D status in soccer players.

The present study had some limitations. The assessment of 25(OH)D status were obtained in a city with lack of sun exposure during wintertime. All of our subjects were playing soccer, so even it is an outdoor sports activity, our results could not be generalized to other sports. Moreover, further investigations designed with larger samples could give better information about the possible association between low levels of vitamin D and higher risk of skeletal muscle injuries.

CONCLUSION

Given our findings, serum 25(OH)D deficiency or insufficiency did not seem to affect muscle strain injury in soccer players. However, due to high prevalance of low vitamin D levels in this region, serum 25(OH)D evaluation should be considered as part of routine screening for general health conditions of athletes. Vitamin D deficiency and insufficiency in athletes with limited sun exposure during winter should be prevented by consuming oral vitamin D dietary supplementation.

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