

Original Article

# Vitamin D deficiency does not associate with anterior cruciate ligament injuries in elite athletes

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## ABSTRACT

**Objectives:** Recently, low levels of Vitamin D levels in sportspersons are observed by many studies. However, the role of low Vitamin D levels on anterior cruciate ligament (ACL) injury is not well studied. The purpose of this study was to find out the correlation between serum Vitamin D levels and ACL injury.

**Materials and Methods:** This is a case-control study in which 55 athletes were enrolled in both cases (ACL deficient) and controls (ACL intact). Serum Vitamin D levels were measured in both the groups (preoperatively and 12 months postoperatively) and depending on the Vitamin D levels, athletes were categorized as Vitamin D deficient (<20 ng/mL), insufficient (20–30 ng/mL), and sufficient (>30 ng/mL). Functional outcomes were assessed using the Lysholm score and Tegner activity score at 12 months follow-up.

**Results:** Overall, 91% of cases and 93% of controls were observed to be Vitamin D deficient or insufficient (n.s.). There was no significant difference among mean Vitamin D levels in cases ( $16.34 \pm 11.89$  ng/mL) and controls ( $18.08 \pm 9.9$ ; n.s.). There was no significant difference in post-operative function outcomes (Lysholm score) between the three groups among cases at 12 months follow-up (n.s.).

**Conclusion:** The presence of low Vitamin D levels is not a risk factor for ACL injuries and low Vitamin D levels are not a hindrance to recovery after ACL reconstruction.

**Keywords:** Anterior cruciate ligament, Vitamin D, Sports injury

## INTRODUCTION

Vitamin D deficiency is endemic in India.<sup>[1,2]</sup> Even athletes are reported to have low levels of Vitamin D.<sup>[3-5]</sup> Vitamin D is observed to have many functions other than bone metabolism.<sup>[6,7]</sup> Vitamin D's role in rotator cuff healing has also been studied.<sup>[8,9]</sup> Vitamin D deficiency is known to cause muscle weakness, predominantly in weight-bearing antigravity muscles necessary for postural balance and walking,<sup>[10]</sup> and studies have also shown a significant correlation between Vitamin D deficiency and the occurrence of falls.<sup>[11]</sup> Since good neuromuscular control is important in athletes to reduce the risk of injuries, it was hypothesized that Vitamin D deficiency may affect neuromuscular control in athletes and render them more susceptible to anterior cruciate ligament (ACL) injury.

The role of Vitamin D deficiency in ACL injury is not well studied. Therefore, the present case-control study was conducted with the aim to compare the Vitamin D levels

among athletes with ACL tears (cases) and athletes having intact ACL (controls). It was hypothesized that athletes with ACL tears will have low serum Vitamin D levels as compared to athletes having intact ACL.

Previous studies have reported that low Vitamin D levels have a negative impact on recovery after ACL reconstruction;<sup>[12]</sup> however, only limited literature is available on this topic. Another aim of the present study was to see the effect of Vitamin D levels on the functional outcome after ACL reconstruction.

## MATERIALS AND METHODS

The present study is a case-control study conducted on professional athletes after the approval of the Institutional Ethical Committee. Informed and written consent was received from all the patients. Athletes were divided into two groups depending on the integrity of the ACL:- Cases (ACL deficient,  $n = 55$ ) and control (intact ACL,  $n = 55$ ). Cases

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were athletes who had ACL tears and controls were athletes who had intact ACL. Cases and controls were matched as controls were selected carefully, considering the following point – level of sports, type of sports, type of player (forward player or raider), body mass index (BMI), age, and sun exposure. Athletes who were involved in outdoor sports and sustained the injury by non-contact mode of injury were enrolled in the study [Table 1]. Exclusion criteria were as follows: History of Vitamin D intake in the past 6 months, history of ACL reconstruction, skin disease affecting melanin pigmentation, and athletes having renal or kidney disease.

**Table 1:** Details of sports played by the cases and controls.

Type of sports	Cases (n=55)	Controls (n=55)
Kabaddi	22	22
Football	17	17
Badminton	4	4
Cricket	3	3
Wrestling	1	1
Volleyball	1	1
Athletic sports	7	7

n: Number of patients

**Table 2:** Demographic comparison of cases and controls.

	Cases	Controls	P-value
Male: Female	44:11	44:11	1
Age (years)	24.5±4.7	24.6±4.9	1
BMI (kg/m <sup>2</sup> )	24.1±2.9	24.2±2.9	1
Mean pre-injury Tegner activity scale	7.6	7.6	1

BMI: Body mass index

**Table 3:** Comparison of Vitamin D levels in cases and controls.

	Mean Vitamin D levels	Vitamin D deficient (<20 ng/mL)	Vitamin D insufficient (20–30 ng/mL)	Vitamin D sufficient (>30 ng/mL)
Cases (n=55)	16.34±11.89	28	22	5
Control (n=55)	18.08±9.9	32	19	4
	0.5	0.6	0.8	0.7

n: Number of patients

**Table 4:** Effect of Vitamin D levels on the functional outcomes of ACL reconstruction.

	Vitamin D deficient (<20 ng/mL)	Vitamin D insufficient (20–30 ng/mL)	Vitamin D sufficient (>30 ng/mL)	P-value
Lysholm score pre-operative	61.2±8.74 (n=28)	60.1±9.57 (n=22)	59.6±8.96 (n=5)	0.9
Lysholm score post-operative at 12 months follow-up	92.5±4.7 (n=26)	92.3±4.1 (n=21)	93.6±4.7 (n=5)	0.8
Pre-injury Tegner activity scale	7.5±1	7.7±0.9	7.7±0.9	0.9
Post-operative Tegner at 12 months follow-up	7.2±0.9	7.25±0.9	7.3±1	0.9

ACL: Anterior cruciate ligament

Blood sample of all the athletes (cases) was taken at the time of enrollment and 12 months postoperatively. Blood was analyzed for serum Vitamin D levels. 25 (OH) D is Vitamin D metabolite and was used to assess the subject's Vitamin D status. Levels were calculated by Advia Centaur® XP immunoassay system (Siemens Healthcare Diagnostic Inc.) with software version 6.1 using the chemiluminescence method. A value of <20 ng/mL was taken as deficient and a value of 20–30 ng/mL was taken as insufficient and >30 ng/mL was taken as sufficient. All the cases were followed for a minimum of 12 months post-ACL reconstruction. At 12 months follow-up, functional outcomes were assessed using the Lysholm score and Tegner activity score. Tegner activity scale is a standard method of determining the activity level of the person that is documented on a numerical scale between 0 and 10, 10 activity level is for competitive sportspersons (national/international players), and 0 for sick or disabled persons. Lysholm knee score is a self-reporting 100 point scoring system that includes the symptoms of mechanical locking, instability, pain, swelling, stair climbing, and squatting. None of the patients received Vitamin D postoperatively. Three cases were lost to follow-up.

### Statistics

Discrete categorical data were presented as percentages (%); continuous data were given as mean ± standard deviation. The normality of quantitative data was checked by measures of Kolmogorov–Smirnov tests of normality. Comparisons for two groups (age, BMI, and mean vitamin D levels) were made by the student *t*-test. Categorical variables were reported as counts and percentages. Group comparisons were made with the Chi-square test or Fisher exact probability test (gender and Vitamin D deficient patients).

## RESULTS

A total of 110 athletes were enrolled in the study, 44 males and 11 females were present in both groups (cases as well as controls). Cases and controls were demographically matched in terms of gender, age, and BMI [Table 2].

Only 5/55 (9%) cases and 4/55 (7%) controls were Vitamin D sufficient [Table 3]. The mean Vitamin D levels among cases and controls were 16.3 ng/mL and 18.1 ng/mL, respectively ( $P = 0.4$ ).

At the final follow-up, 26/52 (50%) were Vitamin D deficient, 21/52 (40%) were Vitamin D insufficient, and 5/52 (10%) were Vitamin D sufficient. It was observed that Vitamin D levels have no impact on the functional outcomes after ACL reconstruction. The mean Tegner activity scale and Lysholm scores were comparable in all three groups [Table 4].

## DISCUSSION

In the present study, no correlation was found between serum Vitamin D levels and ACL injuries. These results are contrary to our hypothesis. Previous studies have reported that athletes with low Vitamin D levels are more prone to injuries.<sup>[13,14]</sup> Shindle *et al.* observed that athletes having low Vitamin D levels were more prone to injury.<sup>[15]</sup> Shafiee *et al.*, in their study, compared the Vitamin D levels among athletes with ACL tear and athletes with intact ACL and they observed that Vitamin D levels were significantly low among the athletes having ACL tear.<sup>[16]</sup> However, other than this single study, there is no other study in the literature that studied the correlation between Vitamin D levels and ACL injury.

Another important finding of the present study was that 91% of cases and 93% of controls were Vitamin D deficient or insufficient. Such a high number of athletes having Vitamin D deficiency is a major concern as Vitamin D levels are reported to affect athletes' performance.<sup>[12,13,17-21]</sup> Therefore, it is important to address this problem seriously. Backx *et al.* observed that nearly 70% of athletes were Vitamin D deficient and after supplementation of Vitamin D, 80% of the athletes had normal values of serum Vitamin D.<sup>[22]</sup>

In the present study, we observed that low levels of Vitamin D have no impact on the effect on recovery after ACL reconstruction. Results are contrary to the previous study which observed that low Vitamin D levels are a hindrance to strength recovery after ACL reconstruction.<sup>[23]</sup>

This study had some limitations – (1) the correlation of Vitamin D level with parathyroid hormone and bone mineral density was not studied in the present study. (2) The sample size of the present study was small; therefore, a study with a large sample size is needed to confirm the findings of this study.

## CONCLUSION

Although low Vitamin D levels are highly prevalent among professional athletes that can impact their on-field

performance, it is not associated with an increased risk of ACL injuries.

### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

### Conflicts of interest

Dr. Ravi Gupta first author of this manuscript is a member of the editorial board.

### Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The author(s) confirms that there was no use of Artificial Intelligence (AI)-Assisted Technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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