

Research Article

Association Between Serum Vitamin D Levels and Clinical Severity of Plantar Fasciitis: A Cross-Sectional Study

Dr Prasanna Biradar¹, Dr Anirudh Uniyal², Dr Rupanjana Sarma^{3*}

¹Assistant Professor, Department of Orthopaedics, Kodagu Institute of Medical Sciences, Madikeri, Karnataka-571201, India

²Senior Resident, Government Doon Medical College, Dehradun-248001, India

³Associate Consultant, Department of Orthopaedics, Tulip Mediworld Superspeciality hospital, Guwahati, Assam-781006, India

*Correspondence: Dr Rupanjana Sarma, Associate Consultant, Department of Orthopaedics, Tulip Mediworld Superspeciality hospital, Guwahati, Assam-781006, India Email: rs.rupanjana@gmail.com

ABSTRACT

Background

Plantar fasciitis is the most common cause of chronic heel pain, accounting for nearly 80% of painful heel disorders encountered in orthopedic practice. The condition is characterized by degeneration of the plantar fascia resulting from repetitive mechanical stress, microtears, and chronic inflammation. Recent evidence suggests that vitamin D plays an important role in musculoskeletal health by regulating bone metabolism, collagen synthesis, muscle function, and inflammatory responses. Vitamin D deficiency has therefore been proposed as a potential contributor to the severity and persistence of plantar fasciitis symptoms.

Objective

To evaluate the association between serum vitamin D levels and the clinical severity of plantar fasciitis among adult patients.

Methods

A hospital-based cross-sectional study was conducted among 218 adult patients diagnosed with plantar fasciitis in IMS and SUM Hospital Bhubaneswar over 2 years of study period. Clinical severity was assessed using the Visual Analog Scale (VAS), Foot Function Index (FFI), duration of symptoms, morning pain severity, and ultrasonographic plantar fascia thickness. Serum 25-hydroxyvitamin D concentrations were measured and categorized as deficient, insufficient, or sufficient. Multivariate regression analysis was performed to determine independent predictors of severe plantar fasciitis.

Results

Vitamin D deficiency was identified in 132 (60.6%) patients. Patients with vitamin D deficiency demonstrated significantly higher VAS pain scores, worse Foot Function Index scores, greater plantar fascia thickness, and longer symptom duration than patients with sufficient vitamin D levels ($p < 0.001$). Multivariate analysis identified vitamin D deficiency, obesity, prolonged symptom duration, and plantar fascia thickness ≥ 4 mm as independent predictors of severe plantar fasciitis.

Conclusion

Vitamin D deficiency was significantly associated with greater clinical severity of plantar fasciitis. Routine assessment of vitamin D status may facilitate comprehensive management of patients presenting with chronic heel pain.

Keywords: Plantar fasciitis, Vitamin D deficiency, Heel pain, Foot Function Index, Ultrasonography, Cross-sectional study.

INTRODUCTION

Plantar fasciitis is one of the most common causes of inferior heel pain and represents a major source of disability among adults. The disorder results from repetitive microtrauma at the origin of the plantar

fascia on the medial calcaneal tubercle, leading to collagen degeneration, fibroblastic proliferation, and chronic degenerative changes rather than acute inflammation. Approximately one in ten individuals experience plantar fasciitis during their lifetime, with the highest prevalence occurring among middle-aged adults, runners, obese individuals, and occupations requiring prolonged standing. Chronic heel pain significantly affects walking ability, occupational performance, and overall quality of life.¹⁻⁴

Vitamin D is increasingly recognized as an important regulator of musculoskeletal health beyond its classical role in calcium and phosphorus metabolism. Active vitamin D influences collagen synthesis, tendon remodeling, muscle strength, neuromuscular coordination, and modulation of inflammatory cytokines. Deficiency of vitamin D has been associated with chronic musculoskeletal pain, tendinopathies, stress fractures, osteoporosis, and impaired tissue healing. Recent investigations have suggested that inadequate vitamin D levels may contribute to plantar fascia degeneration through impaired extracellular matrix remodeling and delayed repair of repetitive microinjuries.⁵⁻⁹

Several clinical factors influence the development and severity of plantar

fasciitis, including obesity, prolonged standing, pes planus, limited ankle dorsiflexion, reduced calf muscle flexibility, repetitive athletic activity, and biomechanical abnormalities of the foot. Ultrasonography has become an important diagnostic modality because it enables objective measurement of plantar fascia thickness, identification of perifascial edema, loss of normal fibrillar architecture, and calcaneal enthesopathy. Recent studies have reported positive correlations between plantar fascia thickness, pain intensity, and functional disability, suggesting that imaging findings may reflect disease severity.^{10–15}

Despite increasing interest in vitamin D deficiency as a potential contributor to chronic musculoskeletal disorders, evidence regarding its relationship with plantar fasciitis remains limited and inconsistent. Better understanding of this association may provide opportunities for early nutritional intervention and improved patient outcomes. Therefore, the present cross-sectional study aimed to evaluate the association between serum vitamin D levels and the clinical severity of plantar fasciitis using clinical assessment, functional outcome scores, laboratory investigations, and ultrasonographic findings.^{16–20}

METHODOLOGY

This hospital-based cross-sectional study was conducted in the Departments of Orthopaedics, IMS and SUM Hospital Bhubaneswar over 2 years of study period, after obtaining approval from the Institutional Ethics Committee. Adult patients diagnosed with plantar fasciitis were consecutively recruited after providing written informed consent.

Patients aged 18–65 years with clinically diagnosed plantar fasciitis characterized by inferior heel pain persisting for more than four weeks and maximal tenderness over the medial calcaneal tubercle were eligible for inclusion. Patients with previous foot surgery, inflammatory arthritis, peripheral neuropathy, diabetes-related foot disease, traumatic heel injuries, malignancy, pregnancy, chronic renal failure, or current vitamin D supplementation were excluded. A total of 218 patients fulfilled the eligibility criteria.

Demographic information including age, sex, body mass index, occupation, duration of symptoms, physical activity, prolonged standing, smoking history, and previous treatment was recorded. Clinical severity was evaluated using the Visual Analog Scale (VAS), Foot Function Index (FFI), morning pain score, and heel tenderness assessment. Ultrasonography was

performed using a high-frequency linear transducer to measure plantar fascia thickness at its calcaneal insertion. Serum 25-hydroxyvitamin D concentrations were measured using chemiluminescent immunoassay and categorized as deficient (<20 ng/mL), insufficient (20–29 ng/mL), or sufficient ($\geq$ 30 ng/mL).

The primary outcome was the association between serum vitamin D levels and clinical severity of plantar fasciitis. Secondary outcomes included identification of demographic and clinical factors associated with severe disease.

Statistical analysis was performed using SPSS version 26. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Student's *t*-test, one-way ANOVA, and Chi-square test were used where appropriate. Variables demonstrating statistical significance on univariate analysis were entered into multivariate logistic regression analysis. A *p*-value less than 0.05 was considered statistically significant.

RESULTS

Table 1. Baseline Demographic and Clinical Characteristics

Variable	Vitamin D Deficient (n=132)	Vitamin D Sufficient (n=86)	p-value
Age (years)	46.8 $\pm$ 8.7	43.1 $\pm$ 9.2	0.004
Female sex	82 (62.1%)	46 (53.5%)	0.214
BMI (kg/m ²)	29.4 $\pm$ 3.8	26.8 $\pm$ 3.5	<0.001
Prolonged standing occupation	74 (56.1%)	36 (41.9%)	0.041
Symptom duration (months)	9.8 $\pm$ 3.6	6.9 $\pm$ 2.8	<0.001
Bilateral plantar fasciitis	38 (28.8%)	16 (18.6%)	0.091

Patients with vitamin D deficiency were significantly older, had higher body mass index, longer symptom duration, and were more frequently engaged in occupations involving prolonged

standing than patients with sufficient vitamin D levels. These findings suggest that both metabolic and mechanical factors contribute to plantar fasciitis severity.

Table 2. Clinical Severity Assessment

Variable	Vitamin D Deficient	Vitamin D Sufficient	p-value
VAS pain score	8.1 ± 1.0	5.9 ± 1.3	<0.001
Foot Function Index	61.8 ± 11.6	42.9 ± 10.4	<0.001
Morning pain score	8.4 ± 0.9	6.2 ± 1.1	<0.001
Heel tenderness score	3.4 ± 0.6	2.5 ± 0.7	<0.001
Walking limitation	76 (57.6%)	22 (25.6%)	<0.001
Need for analgesics	88 (66.7%)	34 (39.5%)	<0.001

Patients with vitamin D deficiency demonstrated significantly greater pain intensity, worse functional impairment, more severe morning pain, and increased walking limitations. These findings indicate a strong relationship between reduced vitamin D status and clinical severity of plantar fasciitis.

Table 3. Laboratory and Ultrasonographic Findings

Variable	Vitamin D Deficient	Vitamin D Sufficient	p-value
Serum Vitamin D (ng/mL)	15.8 ± 3.6	34.6 ± 5.8	<0.001
Plantar fascia thickness (mm)	5.8 ± 0.8	4.6 ± 0.7	<0.001
Calcaneal spur	58 (43.9%)	20 (23.3%)	0.003
Perifascial edema	44 (33.3%)	14 (16.3%)	0.008
Hypoechoic fascia	82 (62.1%)	28 (32.6%)	<0.001
Increased Doppler vascularity	18 (13.6%)	6 (7.0%)	0.136

Ultrasonography demonstrated significantly greater plantar fascia thickness and more frequent structural abnormalities among patients with vitamin D deficiency. These imaging findings support the association between reduced vitamin D levels and more advanced plantar fascia degeneration.

Table 4. Multivariate Logistic Regression Analysis of Predictors of Severe Plantar Fasciitis

Variable	Odds Ratio	95% CI	p-value
Vitamin D deficiency	3.74	2.01–6.95	<0.001
BMI ≥ 30 kg/m ²	2.68	1.42–5.04	0.002
Plantar fascia thickness ≥ 4 mm	2.46	1.31–4.61	0.005
Symptom duration >6 months	2.28	1.22–4.28	0.010
Prolonged standing occupation	1.86	1.01–3.41	0.046
Female sex	1.22	0.68–2.19	0.497

Multivariate analysis identified vitamin D deficiency as the strongest independent predictor of severe plantar fasciitis. Obesity, prolonged symptom duration, increased plantar fascia thickness, and occupations requiring prolonged standing also independently contributed to greater disease severity, emphasizing the multifactorial nature of plantar fasciitis.

DISCUSSION

The present cross-sectional study demonstrated a significant association between serum vitamin D deficiency and increased clinical severity of plantar

fasciitis. Patients with deficient vitamin D levels experienced greater heel pain, poorer functional status, increased plantar fascia thickness, and longer symptom duration compared with individuals having sufficient vitamin D concentrations. Vitamin D deficiency also emerged as the strongest independent predictor of severe plantar fasciitis after adjustment for demographic and clinical variables. These findings suggest that vitamin D may influence both the biological progression and clinical manifestations of plantar fascia degeneration. Recent clinical studies have

similarly reported a high prevalence of hypovitaminosis D among patients with chronic plantar heel pain and have suggested that correction of deficiency may contribute to symptomatic improvement.¹⁻⁴ Vitamin D plays an important role in maintaining musculoskeletal integrity through regulation of calcium metabolism, collagen synthesis, extracellular matrix remodeling, muscle function, and modulation of inflammatory cytokines. Experimental studies have demonstrated the presence of vitamin D receptors within tendon fibroblasts, supporting its involvement in tendon repair and regeneration. Deficiency may impair collagen organization, delay tissue healing, reduce tensile strength, and promote chronic degenerative changes within the plantar fascia. Recent investigations have further shown that inadequate vitamin D levels are associated with tendinopathies involving the Achilles tendon, rotator cuff, patellar tendon, and plantar fascia, supporting the biological plausibility of the present findings.⁵⁻⁹

Patients with vitamin D deficiency demonstrated significantly higher Visual Analog Scale (VAS) pain scores, worse Foot Function Index (FFI) scores, greater morning pain severity, and increased plantar fascia thickness on ultrasonography. Plantar fascia thickening

reflects chronic fibroblastic proliferation, collagen disorganization, edema, and degenerative remodeling resulting from repetitive mechanical overload. The significant association between lower vitamin D concentrations and increased ultrasonographic abnormalities observed in the present study suggests that vitamin D deficiency may influence structural degeneration in addition to symptom severity. Similar relationships between plantar fascia thickness and functional disability have recently been reported using high-resolution musculoskeletal ultrasonography.¹⁰⁻¹⁵

Obesity, prolonged standing, increased plantar fascia thickness, and longer duration of symptoms were also identified as independent predictors of severe plantar fasciitis. Excess body weight increases mechanical loading across the plantar fascia during gait, while prolonged standing results in repetitive microtrauma at the calcaneal insertion. These mechanical factors may interact with metabolic abnormalities such as vitamin D deficiency to accelerate collagen degeneration and impair tissue repair. Contemporary literature increasingly recognizes plantar fasciitis as a multifactorial disorder resulting from the combined effects of biomechanical stress, metabolic dysfunction, obesity, and impaired

connective tissue healing rather than isolated inflammatory processes. Recent studies have similarly emphasized the importance of addressing both mechanical and metabolic contributors during patient management.^{16–21}

The present study possesses several strengths, including comprehensive clinical assessment using validated functional outcome measures, objective ultrasonographic evaluation, and standardized laboratory measurement of serum vitamin D concentrations. However, certain limitations should be acknowledged. The cross-sectional design precludes establishment of causality between vitamin D deficiency and plantar fasciitis severity. Seasonal variation in vitamin D levels, dietary calcium intake, sunlight exposure, and physical activity were not fully evaluated. Furthermore, the study was conducted at a single tertiary care center, which may limit external generalizability. Despite these limitations, the findings support routine assessment of vitamin D status in patients presenting with chronic plantar heel pain. Future prospective interventional studies evaluating the effect of vitamin D supplementation on pain reduction, functional recovery, and ultrasonographic healing are warranted.^{22,23}

CONCLUSION

Serum vitamin D deficiency was significantly associated with increased clinical severity of plantar fasciitis. Patients with deficient vitamin D levels experienced greater pain intensity, poorer functional outcomes, increased plantar fascia thickness, and longer symptom duration. Vitamin D deficiency, obesity, prolonged symptom duration, increased plantar fascia thickness, and prolonged standing were identified as independent predictors of severe plantar fasciitis. Routine evaluation of vitamin D status, together with appropriate nutritional supplementation, weight management, stretching exercises, and biomechanical interventions, may improve the comprehensive management of patients with chronic plantar heel pain.

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