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RESEARCH ARTICLE

Correlation of Serum Vitamin D Levels with Functional Outcome in Patients with Osteoarthritis of the Knee

Dr. Nilesh Loya

Associate Professor, Department of Orthopedic, Annasaheb Chudamam Patil Memorial Medical College, Dhule (A.C.P.M. Medical College, Dhule)

Abstract

Background: Knee osteoarthritis (OA) is the most common degenerative joint disease characterized by pain, stiffness, and functional disability. Recent evidence suggests that Vitamin D deficiency could be involved in cartilage degeneration, muscle weakness and clinical symptom deterioration in OA patients.

Objectives

1. To estimate serum Vitamin D levels in patients with knee osteoarthritis.
2. To assess the correlation between serum Vitamin D levels and functional outcome using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).
3. To evaluate the association of Vitamin D deficiency with disease severity.

Materials and Methods: A prospective observational study was conducted among 100 patients diagnosed with primary knee osteoarthritis attending the Orthopedics outpatient department of a tertiary care hospital. Serum 25-hydroxy Vitamin D [25(OH)D] levels were measured using chemiluminescent immunoassay. Functional outcome was assessed using the WOMAC score. Patients were categorized into Vitamin D deficient (<20 ng/mL), insufficient (20–30 ng/mL), and sufficient (>30 ng/mL) groups. Statistical analysis included Pearson correlation and ANOVA.

Results: The mean serum Vitamin D level among OA patients was 22.8 ± 8.6 ng/mL. Vitamin D deficiency was observed in 52% of patients. Mean WOMAC scores were significantly higher among Vitamin D-deficient patients (58.6 ± 11.4) compared to insufficient (48.7 ± 9.3) and sufficient groups (39.5 ± 8.7) ($p<0.001$). Serum Vitamin D levels demonstrated a significant negative correlation with WOMAC scores ($r = –0.61$, $p<0.001$).

Conclusion: Vitamin D deficiency is highly prevalent among patients with knee osteoarthritis and is significantly associated with poorer functional outcomes. Monitoring and correction of Vitamin D deficiency may contribute to improved clinical management of knee OA.

Keywords: Osteoarthritis, Vitamin D, WOMAC score, Functional outcome, Knee osteoarthritis.

Introduction:

The most common type of arthritis, osteoarthritis (OA), is a major global source of pain, disability, and a lower quality of life for middle-aged and older people. Progressive articular cartilage loss, subchondral bone remodeling, osteophyte production, synovial inflammation, and different degrees of joint dysfunction are the hallmarks of this chronic degenerative joint condition. [1] One of the most frequently impacted joints, the knee joint bears a significant share of the worldwide burden of musculoskeletal disorders. In the upcoming decades, knee osteoarthritis is predicted to become much more common due to aging populations, obesity, sedentary lifestyles, and longer life expectancies. [2]

Genetic, biomechanical, metabolic, and environmental factors combine intricately to cause knee osteoarthritis, a multifactorial illness. Older age, female gender, obesity, prior joint injuries, repetitive mechanical stress, and muscle weakness are examples of traditional risk factors. [3] Patients usually exhibit restricted range of motion, crepitus, morning stiffness, chronic knee pain, and increasing impairment of physical function. As the illness progresses, patients find it more difficult to carry out everyday tasks including walking, ascending stairs, standing up from a seated posture, and keeping balance, which eventually results in significant functional limits and a lower quality of life. [4]

Corresponding author: Dr. Nilesh Loya

The pathogenesis of osteoarthritis was previously considered a simple consequence of aging and mechanical wear of cartilage. However, recent research has established that OA is an active disease process involving inflammation, altered bone metabolism, oxidative stress, and biochemical changes within the joint microenvironment. [5] These findings have prompted investigators to explore the role of various nutritional and metabolic factors in the development and progression of osteoarthritis. Among these factors, Vitamin D has received considerable attention due to its potential involvement in musculoskeletal health and joint function. [6]

Vitamin D is a fat-soluble secosteroid hormone that plays a critical role in calcium and phosphorus homeostasis, bone mineralization, muscle function, and immune regulation. It is synthesized in the skin through exposure to ultraviolet-B radiation and is subsequently converted in the liver to 25-hydroxyvitamin D [25(OH)D], the major circulating form and the best indicator of Vitamin D status. Further hydroxylation in the kidneys produces the biologically active form, 1,25-dihydroxyvitamin D. [7] In addition to its classical role in bone metabolism, Vitamin D exerts numerous extra-skeletal effects through Vitamin D receptors (VDRs), which are expressed in various tissues including skeletal muscle, immune cells, cartilage, and synovial tissue. [8]

Recent evidence suggests that Vitamin D may influence the pathophysiology of osteoarthritis through several mechanisms. Vitamin D receptors have been identified in articular chondrocytes, indicating a direct role in cartilage metabolism and maintenance. Adequate Vitamin D levels are necessary for normal bone remodeling and preservation of subchondral bone integrity. Deficiency may lead to altered bone turnover, increased cartilage degradation, and progression of joint damage. [9] Furthermore, Vitamin D possesses anti-inflammatory and immunomodulatory properties that may help reduce synovial inflammation and inflammatory mediator production within osteoarthritic joints. [10]

In view of these considerations, the present study was undertaken to evaluate serum Vitamin D levels in patients with osteoarthritis of the knee and to determine their correlation with functional outcome as assessed by the WOMAC index. The findings of this study may contribute to a better understanding of the role of Vitamin D in knee osteoarthritis and provide evidence for potential therapeutic interventions aimed at improving patient outcomes.

Materials and Methods

Study Design: Prospective observational study.

Study Setting: Department of Orthopedics in collaboration with the Department of Biochemistry at a tertiary care teaching hospital.

Study Duration: 12 months.

Sample Size:100 clinically and radiologically diagnosed cases of primary knee osteoarthritis.

Inclusion Criteria:

- Age ≥40 years.
- Radiologically confirmed primary knee osteoarthritis.
- Willingness to participate.

Exclusion Criteria

- Rheumatoid arthritis and inflammatory arthritis.
- Chronic kidney disease.
- Chronic liver disease.
- Current Vitamin D supplementation.
- Malignancy.

Data Collection: Detailed history and clinical examination were performed. Functional status was evaluated using WOMAC score.

Biochemical Analysis

5 ml of venous blood was collected under aseptic precautions.

Serum Vitamin D [25(OH)D]: Method: Chemiluminescent Microparticle Immunoassay (CMIA) Instrument: Automated Immunoassay Analyzer

Reference Range:

Deficient: <20 ng/mL

Insufficient: 20–30 ng/mL

Sufficient: >30 ng/mL

Statistical Analysis:

Data were analyzed using SPSS version 26. Results were expressed as Mean ± SD. ANOVA and Pearson correlation tests were applied. A p-value <0.05 was considered statistically significant.

Results

Table 1. Demographic Characteristics of Study Participants

Parameter	Value
Number of Patients	100
Mean Age (Years)	61.4 ± 8.5
Male	38 (38%)
Female	62 (62%)
BMI (kg/m²)	28.3 ± 4.2
Duration of Symptoms (Years)	5.8 ± 2.7

Table 1 shows the demographic characteristics of the 100 patients with knee osteoarthritis included in the study. The mean age was 61.4 ± 8.5 years, indicating that most participants were elderly. Females (62%) outnumbered males (38%), suggesting a higher prevalence of osteoarthritis among women. The mean BMI was 28.3 ± 4.2 kg/m², indicating that most patients were overweight. The average duration of symptoms was 5.8 ± 2.7 years, reflecting the chronic nature of the disease. Overall, the study population consisted predominantly of older, overweight females with long-standing knee osteoarthritis.

Table 2. Distribution of Patients According to Serum Vitamin D Status

Vitamin D Status	Number (%)
Deficient (<20 ng/mL)	52 (52%)
Insufficient (20–30 ng/mL)	30 (30%)
Sufficient (>30 ng/mL)	18 (18%)

Mean Serum Vitamin D Level = **22.8 ± 8.6 ng/mL**

Table 2 shows the distribution of patients according to their serum Vitamin D status. Among the 100 patients with knee osteoarthritis, **52% were Vitamin D deficient**, **30% had insufficient Vitamin D levels**, and only **18% had sufficient Vitamin D levels**. The mean serum Vitamin D concentration was **22.8 ± 8.6 ng/mL**, which falls within the insufficient range. These findings indicate a high prevalence of Vitamin D deficiency and insufficiency among patients with knee osteoarthritis, suggesting a possible association between low Vitamin D levels and the disease.

Table 3. Comparison of WOMAC Scores According to Vitamin D Status

Vitamin D Category	WOMAC Score
Deficient	58.6 ± 11.4
Insufficient	48.7 ± 9.3
Sufficient	39.5 ± 8.7
p-value	<0.001

Table 3 compares the mean WOMAC scores among patients with different Vitamin D status. Patients with **Vitamin D deficiency** had the highest WOMAC score (**58.6 ± 11.4**), indicating greater pain, stiffness, and functional disability. Patients with **Vitamin D insufficiency** had a moderate WOMAC score (**48.7 ± 9.3**), while those with **sufficient Vitamin D levels** had the lowest WOMAC score (**39.5 ± 8.7**), reflecting better functional status. The difference in WOMAC scores among the three groups was **statistically highly significant ($p < 0.001$)**. These findings suggest that lower Vitamin D levels are associated with poorer functional outcomes in patients with knee osteoarthritis.

Discussion:

Present study Table 1 shows the demographic characteristics of the 100 patients with knee osteoarthritis included in the study. The mean age was 61.4 ± 8.5 years, indicating that most participants were elderly. Females (62%) outnumbered males (38%), suggesting a higher prevalence of osteoarthritis among

women. The mean BMI was 28.3 ± 4.2 kg/m², indicating that most patients were overweight. The average duration of symptoms was 5.8 ± 2.7 years, reflecting the chronic nature of the disease. Overall, the study population consisted predominantly of older, overweight females with long-standing knee osteoarthritis.

Similar observations were reported by **Heidari et al. (2011)**, who found that knee osteoarthritis was more prevalent in older adults and women, with increasing age and obesity being significant risk factors for disease development. [11] Likewise, Zhang and Jordan (2010) reported that advancing age, female gender, and elevated body mass index were strongly associated with the occurrence and progression of knee osteoarthritis. [12]

Present study Table 2 shows the distribution of patients according to their serum Vitamin D status. Among the 100 patients with knee osteoarthritis, **52% were Vitamin D deficient**, **30% had insufficient Vitamin D levels**, and only **18% had sufficient Vitamin D levels**. The mean serum Vitamin D concentration was **22.8 ± 8.6 ng/mL**, which falls within the insufficient range. These findings indicate a high prevalence of Vitamin D deficiency and insufficiency among patients with knee osteoarthritis, suggesting a possible association between low Vitamin D levels and the disease.

Similar findings were reported by **Sanghi et al. (2013)**, [13] who observed that Vitamin D deficiency was highly prevalent among patients with primary knee osteoarthritis and was associated with increased pain and functional impairment. **Bergink et al. (2009) [14]** also demonstrated that lower Vitamin D levels were common in patients with osteoarthritis and might contribute to disease progression through effects on cartilage and subchondral bone metabolism.

Present study Table 3 compares the mean WOMAC scores among patients with different Vitamin D status. Patients with **Vitamin D deficiency** had the highest WOMAC score (**58.6 ± 11.4**), indicating greater pain, stiffness, and functional disability. Patients with **Vitamin D insufficiency** had a moderate WOMAC score (**48.7 ± 9.3**), while those with **sufficient Vitamin D levels** had the lowest WOMAC score (**39.5 ± 8.7**), reflecting better functional status. The difference in WOMAC scores among the three groups was **statistically highly significant ($p < 0.001$)**. These findings suggest that lower Vitamin D levels are associated with poorer functional outcomes in patients with knee osteoarthritis.

These findings are consistent with those reported by **Sanghi et al. (2013) [13]** who observed that Vitamin D-deficient patients with knee osteoarthritis had significantly higher pain and WOMAC scores compared to patients with adequate Vitamin D levels. Similarly, **Heidari et al. (2011) [11]** found that Vitamin D deficiency was associated with increased pain severity and reduced physical function in patients with knee osteoarthritis.

Conclusion

Vitamin D deficiency is highly prevalent among patients with knee osteoarthritis and is significantly associated with poorer functional outcomes. Serum Vitamin D levels showed a strong negative correlation with WOMAC scores. Routine assessment of Vitamin D status may be beneficial in OA patients, and correction of deficiency could potentially improve functional outcomes and quality of life.

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