International Journal of Medicine
pISSN 1468-3814 | eISSN 2667-7008
https://theinternationalmedicine.com/

Original Researcher Article *DOI: 10.61336/im/24-01-39*

Association Of Vitamin D Status With Fracture Pattern And Functional Outcome In Elderly Patients With Fragility Hip Fractures: A Prospective Observational Study.

Dr. Sainath Pattewar[1], Dr. Basudev Agrawal[2], Dr. Pawan Shaw[3]*

[1]*Associate Professor, Department of General Medicine, Shri Balaji Institute of Medical Sciences, Raipur, Chhattisgarh, India*
[2]*Assistant Professor, Department of Radio-Diagnosis, Shri Balaji Institute of Medical Sciences, Raipur, Chhattisgarh, India*
[3]*Assistant Professor, Department of Orthopaedics, Shri Balaji Institute of Medical Sciences, Raipur, Chhattisgarh, India*

Correspondence:
Dr. Pawan Shaw.
Assistant Professor, Department of Orthopaedics, Shri Balaji Institute of Medical Sciences, Raipur, Chhattisgarh, India.

Received: 01-10-2024
Revised: 18-10-2024
Accepted: 08-11-2024
Published: 28-11-2024

Abstract

Background: Fragility hip fractures are an important cause of morbidity, loss of independence and mortality among older adults. Vitamin D deficiency is common in the elderly and may contribute to reduced bone mineralization, muscle weakness, falls and impaired recovery following fracture. The present study evaluated vitamin D status in elderly patients with fragility hip fractures and examined its association with radiological fracture pattern and short-term functional outcome. ***Materials and Methods***: This prospective observational study included 120 patients aged ≥60 years presenting with low-energy hip fractures to a tertiary-care hospital. Clinical characteristics, comorbidities, serum 25-hydroxyvitamin D [25(OH)D], calcium, phosphorus, alkaline phosphatase, renal function and haemoglobin were recorded. Fractures were classified radiologically as femoral neck or intertrochanteric fractures. Vitamin D status was categorized as deficient (<20 ng/mL), insufficient (20–29.9 ng/mL) or sufficient (≥30 ng/mL). Functional outcome was assessed using the Modified Harris Hip Score (mHHS) at three months. ***Results***: The mean age of participants was 71.8 ± 7.9 years, and 68 (56.7%) were women. Vitamin D deficiency was observed in 72 patients (60.0%), insufficiency in 30 (25.0%) and sufficiency in 18 (15.0%). Thus, 85.0% of patients had vitamin D levels below 30 ng/mL. Intertrochanteric fractures were present in 70 (58.3%) patients and femoral neck fractures in 50 (41.7%). The mean three-month mHHS was significantly lower among vitamin D-deficient patients compared with patients having vitamin D levels ≥20 ng/mL (61.4 ± 12.6 vs. 70.8 ± 11.3; p<0.001). Vitamin D-deficient patients also demonstrated a greater frequency of poor functional outcome (38.9% vs. 16.7%; p=0.009). Increasing age, vitamin D deficiency and presence of two or more medical comorbidities were independently associated with poorer functional recovery. ***Conclusion***: Vitamin D deficiency was highly prevalent among elderly patients presenting with fragility hip fractures and was associated with poorer short-term functional recovery. Hip fracture admission represents an important opportunity for comprehensive evaluation of bone health, nutritional status and medical comorbidities. A multidisciplinary approach involving physicians, orthopaedic surgeons and radiologists may help identify modifiable risk factors and optimize secondary fracture prevention.

Keywords: Vitamin D deficiency; Hip fracture; Fragility fracture; Osteoporosis; Elderly; Modified Harris Hip Score; Intertrochanteric fracture.

INTRODUCTION

Hip fractures constitute one of the most serious consequences of osteoporosis and age-related skeletal fragility. With increasing life expectancy, the number of older adults at risk of fragility fractures is expected to rise substantially. Apart from the immediate requirement for hospitalization and surgical management, hip fractures may result in prolonged immobility, functional dependence, postoperative complications and increased mortality.

The pathogenesis of fragility fractures is multifactorial. Advancing age, osteoporosis, sarcopenia, falls, impaired vision, polypharmacy, nutritional deficiencies and chronic systemic illnesses contribute to fracture risk. Vitamin D has an important role in calcium homeostasis, skeletal mineralization and neuromuscular function. Deficiency may lead to secondary hyperparathyroidism, increased bone turnover, muscle weakness and increased susceptibility to falls.

Vitamin D deficiency remains common in India despite abundant sunlight. Several factors including inadequate dietary intake, limited outdoor activity, ageing, reduced cutaneous vitamin D synthesis and comorbid diseases may contribute to deficiency among elderly individuals.
Patients presenting with a low-energy hip fracture provide an important opportunity for identifying underlying metabolic and medical abnormalities. However, evaluation of vitamin D status and secondary fracture risk may receive less attention during acute fracture management.

The present study was therefore undertaken to determine the prevalence of vitamin D deficiency among elderly patients presenting with fragility hip fractures and to examine its relationship with fracture pattern and short-term functional outcome.

AIM AND OBJECTIVES

Aim

To evaluate vitamin D status and its association with clinical, radiological and functional outcomes among elderly patients presenting with fragility hip fractures.

Primary Objective

To determine the prevalence of vitamin D deficiency among elderly patients with fragility hip fractures.

Secondary Objectives

1. To evaluate the association between serum vitamin D levels and type of hip fracture.
2. To compare functional recovery according to vitamin D status.
3. To assess the relationship between medical comorbidities and functional outcome.
4. To identify predictors of poor functional recovery following hip fracture.

MATERIALS AND METHODS

Study Design and Setting

A prospective hospital-based observational study was conducted in the Departments of General Medicine, Orthopaedics and Radio-Diagnosis at Shri Balaji Institute of Medical Sciences, Raipur, Chhattisgarh.

Study Population

Patients aged 60 years or above presenting with a radiologically confirmed fragility fracture of the proximal femur were considered for inclusion.

Sample Size

A total of **120 patients** fulfilling the eligibility criteria were included.

Inclusion Criteria

- Age ≥60 years.
- Low-energy fracture following fall from standing height or less.
- Femoral neck or intertrochanteric fracture confirmed radiologically.
- Availability of serum 25(OH)D measurement.
- Consent for participation and follow-up.

Exclusion Criteria

- High-energy trauma.
- Pathological fracture secondary to malignancy.
- Previous ipsilateral hip surgery.
- Severe chronic kidney disease requiring dialysis.
- Known metabolic bone disorders other than osteoporosis.
- Long-term treatment with medications substantially affecting bone metabolism where adequate clinical information was unavailable.
- Patients unable to complete follow-up assessment.

Clinical Evaluation

Demographic details, mechanism of injury, previous fractures, history of falls, smoking, alcohol consumption and medication history were recorded. Medical comorbidities including hypertension, diabetes mellitus, coronary artery disease, chronic respiratory disease and chronic kidney disease were documented.

Laboratory Investigations

Venous blood samples were obtained during admission for:

- Serum 25-hydroxyvitamin D
- Serum calcium
- Serum phosphorus
- Serum alkaline phosphatase
- Haemoglobin
- Serum creatinine
- Blood glucose

Vitamin D status was categorized as:

- **Deficient:** <20 ng/mL
- **Insufficient:** 20–29.9 ng/mL
- **Sufficient:** ≥30 ng/mL

Radiological Assessment

Plain radiographs of the pelvis with both hips and dedicated views of the affected hip were evaluated by the Department of Radio-Diagnosis. Fractures were broadly categorized into:

1. Femoral neck fractures
2. Intertrochanteric fractures

Additional imaging was performed whenever clinically indicated.

Treatment and Follow-up

Patients were managed according to fracture configuration, age, functional requirements, medical fitness and treating surgeon's clinical judgment.

Functional assessment was performed at approximately three months using the **Modified Harris Hip Score (mHHS)**. Outcomes were categorized as:

- Excellent: ≥90
- Good: 80–89
- Fair: 70–79
- Poor: <70

Statistical Analysis

Data were analyzed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation and categorical variables as frequency and percentage. Student's t-test or analysis of variance was used for normally distributed continuous variables, while categorical variables were compared using the chi-square test or Fisher's exact test. Multivariable logistic regression was used to identify factors independently associated with poor functional outcome. A p-value <0.05 was considered statistically significant.

RESULTS

Patient Characteristics

A total of 120 patients were included. The mean age was **71.8 ± 7.9 years**, ranging from 60 to 91 years. There were 68 (56.7%) women and 52 (43.3%) men.

Table 1. Baseline characteristics of study participants

Characteristic	Value
Total patients	120
Mean age, years	71.8 ± 7.9
Male	52 (43.3%)
Female	68 (56.7%)
Hypertension	62 (51.7%)
Diabetes mellitus	41 (34.2%)
Coronary artery disease	16 (13.3%)
≥2 medical comorbidities	44 (36.7%)
Previous history of fragility fracture	18 (15.0%)
Intertrochanteric fracture	70 (58.3%)
Femoral neck fracture	50 (41.7%)

Vitamin D Status

The mean serum 25(OH)D concentration was **18.7 ± 9.4 ng/mL**.
Vitamin D deficiency was identified in 72 (60.0%) patients, while another 30 (25.0%) had vitamin D insufficiency. Only 18 (15.0%) had levels ≥30 ng/mL.

Table 2. Distribution according to vitamin D status

Vitamin D status	Patients, n (%)
Deficient (<20 ng/mL)	72 (60.0%)
Insufficient (20–29.9 ng/mL)	30 (25.0%)
Sufficient (≥30 ng/mL)	18 (15.0%)
Overall level <30 ng/mL	**102 (85.0%)**

Vitamin D deficiency was more frequent among women than men (66.2% vs. 51.9%), although the difference did not reach statistical significance (p=0.11).

Vitamin D and Fracture Pattern
Among the 72 vitamin D-deficient patients, 46 (63.9%) had intertrochanteric fractures and 26 (36.1%) had femoral neck fractures.

Table 3. Fracture pattern according to vitamin D status

Fracture pattern	Vitamin D deficient (n=72)	Vitamin D ≥20 ng/mL (n=48)	p-value
Intertrochanteric	46 (63.9%)	24 (50.0%)	0.13
Femoral neck	26 (36.1%)	24 (50.0%)	

Although intertrochanteric fractures were proportionately more common among deficient patients, the association was not statistically significant.

FUNCTIONAL OUTCOME
At three-month follow-up, the overall mean Modified Harris Hip Score was 65.2 ± 12.9.
Patients with vitamin D deficiency demonstrated significantly poorer functional scores.

Table 4. Vitamin D status and three-month functional outcome

Parameter	Vitamin D deficient	Vitamin D ≥20 ng/mL	p-value
Mean mHHS	61.4 ± 12.6	70.8 ± 11.3	**<0.001**
Poor outcome	28 (38.9%)	8 (16.7%)	**0.009**
Fair/Good/Excellent outcome	44 (61.1%)	40 (83.3%)	

Thus, patients with vitamin D deficiency demonstrated a substantially greater frequency of poor functional recovery.

FACTORS ASSOCIATED WITH POOR FUNCTIONAL OUTCOME
On univariate analysis, increasing age, vitamin D deficiency, presence of multiple medical comorbidities and lower baseline haemoglobin were associated with poorer functional recovery.
After adjustment in multivariable analysis, three factors remained independently associated with poor outcome:

Table 5. Multivariable predictors of poor functional outcome

Predictor	Adjusted OR	95% CI	p-value
Age ≥75 years	2.41	1.08–5.38	0.032
Vitamin D deficiency	2.76	1.14–6.68	0.024
≥2 medical comorbidities	2.53	1.10–5.83	0.029

DISCUSSION
The present study demonstrates a high prevalence of inadequate vitamin D status among elderly patients presenting with fragility fractures of the hip. Eighty-five percent of patients had serum 25(OH)D levels below 30 ng/mL and 60% fulfilled the criterion for vitamin D deficiency.

These findings are relevant in the Indian setting, where hypovitaminosis D is frequently reported despite abundant sunlight. Ageing may further increase the risk through reduced cutaneous synthesis, decreased outdoor activity, inadequate nutrition and associated chronic illnesses.

The predominance of women in the present study is consistent with the recognized increase in fragility fracture risk following menopause. Reduced estrogen levels accelerate bone loss, and this effect may be compounded by inadequate vitamin D and calcium intake.

Intertrochanteric fractures constituted the commonest fracture pattern in the study. Although a greater proportion of vitamin D-deficient patients had intertrochanteric fractures, the difference was not statistically significant. This suggests that vitamin D deficiency should be regarded primarily as one component of the broader skeletal and neuromuscular risk profile rather than as an isolated determinant of fracture morphology.

An important observation was the relationship between vitamin D deficiency and functional recovery. Vitamin D-deficient patients had significantly lower three-month Modified Harris Hip Scores and a higher prevalence of poor outcome. Vitamin D influences both skeletal and muscle physiology. Deficiency may therefore potentially affect rehabilitation through muscle weakness, impaired balance and coexisting frailty.

Nevertheless, the relationship between vitamin D and outcomes following hip fracture remains complex. Previous studies have not uniformly demonstrated an independent relationship between vitamin D deficiency and postoperative mortality or complications. Consequently, vitamin D should not be considered in isolation when assessing prognosis.

Age and medical comorbidity were also independently associated with poorer functional recovery in the present study. This reinforces the importance of orthogeriatric or multidisciplinary management. Elderly fracture patients frequently have diabetes, hypertension, cardiovascular disease, anaemia, renal dysfunction and nutritional abnormalities that influence perioperative risk and rehabilitation.

The physician therefore has an important role in perioperative optimization and identification of secondary contributors to bone fragility, while the orthopaedic surgeon provides definitive fracture management and directs mobilization and rehabilitation. Radiological evaluation is essential for accurate fracture characterization and can additionally identify features suggestive of reduced bone quality or underlying pathology.
Hip fracture should therefore be viewed not merely as an isolated traumatic event but as a potential clinical marker of underlying osteoporosis and increased future fracture risk. Following stabilization of the acute fracture, patients should undergo appropriate evaluation for osteoporosis and secondary fracture prevention.

It is also important to distinguish treatment of documented deficiency or osteoporosis from indiscriminate vitamin D supplementation in otherwise healthy adults. Large randomized evidence has shown that vitamin D supplementation alone does not necessarily reduce fracture incidence among generally healthy adults without selected vitamin D deficiency or osteoporosis. Management should consequently be individualized according to nutritional status, bone health and overall fracture risk.

CLINICAL IMPLICATIONS

The findings support a comprehensive approach to elderly patients admitted with fragility hip fractures. In addition to surgical treatment, evaluation should include assessment of vitamin D status, calcium balance, renal function, anaemia, nutritional status, medical comorbidities, osteoporosis risk and falls.
Where clinically appropriate, secondary fracture prevention should include correction of documented vitamin D deficiency, adequate calcium intake, osteoporosis assessment and treatment, rehabilitation, muscle-strengthening measures and strategies to reduce future falls.

LIMITATIONS

The present study has several limitations. It was conducted at a single tertiary-care centre with a relatively modest sample size. Vitamin D was measured at a single time point, and seasonal variations were not assessed. Bone mineral density measurements were not available for every participant. Functional outcome was assessed at three months; longer follow-up would provide additional information regarding recovery, subsequent fractures and mortality. Residual confounding related to nutritional status, frailty, physical activity and socioeconomic factors is also possible.

CONCLUSION

Vitamin D deficiency is highly prevalent among elderly patients presenting with fragility hip fractures. In the present study, deficient vitamin D status was associated with poorer three-month functional recovery, while advanced age and multiple medical comorbidities were additional predictors of adverse functional outcome.
Fragility hip fracture should trigger comprehensive evaluation beyond surgical management alone. Collaboration between **General Medicine, Orthopaedics and Radio-Diagnosis**, together with appropriate rehabilitation and osteoporosis assessment, may facilitate identification of modifiable risk factors and improve secondary fracture-prevention strategies.

DECLARATIONS

Ethical Approval:

Yes, the study conducted after approval from the Institutional Ethics Committee.

Conflict of Interest:
The authors declare no conflict of interest.

Funding:
No external funding.

Acknowledgement:
The authors acknowledge the clinical, nursing and technical staff involved in the evaluation, treatment and follow-up of the study participants.

Data Availability:
Data generated during the study may be made available from the corresponding author on reasonable request, subject to institutional and ethical requirements.

REFERENCES

1. Mithal A, Wahl DA, Bonjour JP, et al. Global vitamin D status and determinants of hypovitaminosis D. Osteoporos Int. 2009;20(11):1807-1820.
2. Harinarayan CV, Joshi SR. Vitamin D status in India—its implications and remedial measures. J Assoc Physicians India. 2009;57:40-48.
3. Dhanwal DK, Dennison EM, Harvey NC, Cooper C. Epidemiology of hip fracture: worldwide geographic variation. Indian J Orthop. 2011;45(1):15-22.
4. Lips P. Vitamin D deficiency and secondary hyperparathyroidism in the elderly: consequences for bone loss and fractures and therapeutic implications. Endocr Rev. 2001;22(4):477-501.
5. Holick MF. Vitamin D deficiency. N Engl J Med. 2007;357(3):266-281.
6. Bischoff-Ferrari HA, Willett WC, Wong JB, et al. Prevention of nonvertebral fractures with oral vitamin D and dose dependency: a meta-analysis of randomized controlled trials. Arch Intern Med. 2009;169(6):551-561.
7. Khadgawat R, Brar KS, Gahlo M, Yadav CS, Malhotra R, Gupt N, Tandon N. High prevalence of vitamin D deficiency in Asian-Indian patients with fragility hip fracture: a pilot study. J Assoc Physicians India. 2010;58:539-542.
8. Ramason R, Selvaganapathi N, Ismail NHB, et al. Prevalence of vitamin D deficiency in patients with hip fracture seen in an orthogeriatric service in sunny Singapore. Geriatr Orthop Surg Rehabil. 2014;5(2):82-86.
9. Gorter EA, Krijnen P, Schipper IB. Vitamin D deficiency in adult fracture patients: prevalence and risk factors. Eur J Trauma Emerg Surg. 2016;42(3):369-378.
10. Maier GS, Jakob P, Horas K, Roth KE, Kurth AA, Maus U. Vitamin D deficiency in orthopaedic patients: a single center analysis. Acta Orthop Belg. 2013;79(5):587-591.
11. Reddy SV, Ramesh V, Babu AS, et al. Hypovitaminosis D in patients with osteoporotic hip fractures. J Clin Orthop Trauma. 2019;10(4):768-773.
12. LeBoff MS, Chou SH, Ratliff KA, et al. Supplemental vitamin D and incident fractures in midlife and older adults. N Engl J Med. 2022;387(4):299-309.
13. Qaseem A, Hicks LA, Etxeandia-Ikobaltzeta I, et al. Pharmacologic treatment of primary osteoporosis or low bone mass to prevent fractures in adults: a living clinical guideline from the American College of Physicians. Ann Intern Med. 2023;176(2):224-238.
14. Fu G, Wu R, Zhang R, et al. Preoperative vitamin D deficiency is associated with increased one-year mortality in Chinese geriatric hip fracture patients: a propensity score matching study. Clin Interv Aging. 2023;18:263-272.
15. Hingankar K, Kedari A, Gandhi RP, Jiwani R. Vitamin D status and its effect on functional outcome in patients with hip fracture: an observational study. Asian J Pharm Clin Res. 2023;16(10).
16. Morin SN, Feldman S, Funnell L, et al. Clinical practice guideline for management of osteoporosis and fracture prevention in Canada: 2023 update. CMAJ. 2023;195(39):E1333-E1348.