



# High prevalence of vitamin D deficiency and osteoporosis in patients with fragility fractures of hip: A pilot study



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## ARTICLE INFO

### Article history:

Received 12 February 2019

Received in revised form

15 March 2019

Accepted 17 March 2019

Available online 21 March 2019

### Keywords:

Vitamin D deficiency

Fragility fractures

Osteoporosis

DXA scan

25(OH)D

proximal femur

hip

## ABSTRACT

**Background:** Vitamin D deficiency (VDD) is a major cause of poor bone health that could lead to fragility fractures, however, there is paucity of literature on prevalence of VDD and associated bone mass in patients of fragility fractures. Hip and spine are the commonest region affected by these fractures and the present study was conceptualised to ascertain the prevalence of VDD and bone mass in patients of hip fragility fractures (proximal femur) to evaluate their role in incidence of these fractures.

**Methods and materials:** Between January 2013 and December 2013, 66 patients of fragility fractures around hip with age more than 50 years presented to our out patient department. Baseline evaluation of calcium profile, renal function tests, parathyroid hormone and 25(OH)D were done. All patients underwent DXA scan of the non-fractured hip.

**Results:** Total number of male patients was 29 and females was 37, with mean age of 64.1 and 70.3 years, respectively. Intertrochanteric femur fractures were the most common type with 35 cases. Fall in bathroom was the most common mode of injury with 36 cases (54.5%). VDD was found in 74.2% of all patients. Prevalence of secondary hyperparathyroidism was observed in 27 patients. Osteopenia, osteoporosis and severe osteoporosis were observed in 15.2%, 62.1% and 18.2% of patients respectively. Sun light exposure was inadequate in 59% of patients with only 1 female patient having adequate exposure.

**Conclusion:** Prevalence of Vitamin D deficiency is very high in patients with hip fragility (proximal femur) fractures with secondary hyperparathyroidism and osteoporosis commonly associated. These fractures in our part of the world, occur at a younger age group as compared to the Western population. Majority of the patients sustain in-house fractures.

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## 1. Introduction

Osteoporosis is a major public health problem around the world, largely due to the morbidity and mortality associated with them. Although spine fractures are more common, hip fractures are also a major cause of such morbidity and mortality. Calcium and vitamin D play an important role in determining bone health. Vitamin D deficiency (VDD) in adults leads to low bone mass, increase risk of falls and hence it predisposes for fractures.<sup>1</sup> Severe VDD can cause osteomalacia and muscle weakness, and subsequent increase in the risk of fragility fractures.<sup>1</sup> Vitamin D deficiency is also an important risk factor for osteoporotic fractures in all age groups especially among elderly population. Prevalence of VDD in elderly patients

with hip fractures varies from 50 to 62% in different population in various geographical areas.<sup>2–4</sup> VDD is widely prevalent among Indians, being reported in almost all age groups of both genders.<sup>5–8</sup>

Fragility fractures result from low energy or trivial trauma and are caused by mechanical forces that do not ordinarily result in fracture. Decreased bone mineral density (BMD) or osteopenia is a major risk factor. Such a bone has insufficient tolerance for low energy trauma and easily breaks. There is paucity of literature on prevalence of VDD and bone mass status in Indian patients with fragility hip fracture. In the present study we present Vitamin D status and BMD in patients with these fractures.

## 2. Material and methods

The study was conducted from January 2013 to December 2013 at the Advanced Trauma Centre of our institute, was approved

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by the Ethics committee and written informed consent was obtained from each participant. In this prospective observational study 66 patients of fragility fractures of either gender with age more than 50 years, were included. Fragility fracture is due to low intensity trauma sustained by an individual when he falls from a height less than his or her own height. Only radiologically proven fractures of the proximal femur, including neck of femur (NOF), the intertrochanteric (IT) and subtrochanteric (ST) fractures were included in the study. Patients having history of malignancy, major trauma or involvement of other bones or joints were excluded. Clinical, biochemical and radiological details of each participant were recorded in a preformed performa.

Fasting venous blood samples were obtained at baseline for biochemical and hormonal measurements. Serum calcium (RR 8.6–10.2 mg/dl), inorganic phosphate (RR 2.7–4.5 mg/dl), albumin (RR 3.4–4.8 mg/dl), alkaline phosphatase (RR 40–129 IU/l), creatinine (RR 0.4–1.2 mg/dl) were measured by auto-analyzer (Roche Diagnostics, Modular P 800 Germany). Serum intact parathyroid hormone (RR iPTH) (13–54 pg/ml) and 25(OH) D (RR 11.1–49.2 ng/ml) were measured by chemiluminescence assay using commercially available kits (Elecys 2010 system, Roche Diagnostics, Germany), at the department of endocrinology laboratory.

VDD was defined at level of <20 ng/ml, with 21–29 ng/ml considered as a state of relative insufficiency, and a level of  $\geq 30$  ng/ml was considered vitamin D sufficient.<sup>9–11</sup> All patients underwent a DXA scan for bone mineral density of the non-fractured hip. DXA scan was done on Hologic viewer 6.0 with WHO standards for T score calculation comparing BMD to average values for young healthy women, that is used to define the categories. Model- Discovery A (S/N 87292). Osteoporosis was defined as per WHO criteria that encompasses grades as per T score Normal (T-score  $-1.0$  and above); Low bone mass, referred to as osteopenia (T-score between  $-1.0$  and  $-2.5$ ); Osteoporosis (T-score  $-2.5$  and below) and Severe osteoporosis (T-score  $-2.5$  and below with fracture).<sup>9</sup>

### 3. Statistical analysis

The data was analysed using statistical software [ SPSS 20.0 (Statistical Package for the Social Sciences) for Windows, Chicago, Illinois, USA ]. Difference between the two means was evaluated using Student's *t*-test (normally distributed data) or Mann–Whitney *U* test (non normally distributed data). Correlations were examined using Spearman's rank correlation test. Chi-square test was used to assess differences in the proportion between qualitative data. The level of significance between the groups and within the groups was identified by applying ANOVA test followed by post hoc test – Student NeumanKeuls procedure for pairwise comparison.

### 4. Results

Baseline data: Out of 66 patients, 43.9% (N = 29) were men and 56.1% (N = 37) were women with mean age of 64.1 $\pm$  13.8 and 70.3 $\pm$ 12.1 years, respectively. The most common site of fracture was inter trochanteric (53%; N = 35), followed by neck of femur (37.9%; N = 25) and subtrochanteric fractures (9.1%; N = 6) [Table 1]. Most of the patients sustained fractures at home (49; 74.2%), with fall in bathroom/wet floor, as the leading cause of fracture, 36/66 (54.5%).

VDD was found in 74.2% (49) patients, among which 72.4% were men (21/66) and 75.7% women (28/66). The mean serum 25(OH) D levels in men and women was 10.1  $\pm$  9.5 ng/ml and 9.7  $\pm$  9.1 ng/ml respectively. Thirty seven patients (56.06%) had 25(OH) D less than 10 ng/ml and further 12 had between 10 and 20 ng/ml. There were

**Table 1**

The mean BMD hip and spine values among the three fracture types included in this study.

Type of Fracture	Frequency (%)	Mean hip BMD	Mean spine BMD
Intertrochanteric	35	0.611 $\pm$ 0.119	0.860 $\pm$ 0.134
Neck of femur	25	0.662 $\pm$ 0.102	0.847 $\pm$ 0.227
Subtrochanteric	6	0.517 $\pm$ 0.340	0.788 $\pm$ 0.506
Total	66	0.622 $\pm$ 0.112	0.848 $\pm$ 0.208

9 patients who had the level between 20 and 30 ng/ml and the remaining 8 patients had 25(OH)D above 30 ng/ml.

The mean serum PTH value in men was 67.4  $\pm$  3.78 pg/ml and in women was 106.2  $\pm$  15.02 pg/ml. The prevalence of secondary hyperparathyroidism was observed in 27 patients (40.9%), out of which 12 (44.4%) were men and 15 (55.6%) were women.

The mean BMD of hip was 0.622  $\pm$  0.126 g/cm<sup>2</sup> and that of spine was 0.848  $\pm$  0.245 g/cm<sup>2</sup>. The prevalence of osteopenia, osteoporosis and severe osteoporosis was observed in 15.2%, 62.1% and 18.2% of patients respectively [Table 2]. In men and women BMD was 0.620  $\pm$  0.221 g/cm<sup>2</sup> and 0.624  $\pm$  0.119 g/cm<sup>2</sup> for hip, and 0.892  $\pm$  0.307 g/cm<sup>2</sup> and 0.815  $\pm$  0.218 g/cm<sup>2</sup> for spine, respectively.

Majority of the patients (81.8%) did not receive any calcium and vitamin D supplementation prior to fragility fracture. There was no significant difference observed in BMD with relation to severity of vitamin D deficiency.

Out of 66 patients 14 (21.21%) were smokers and 12 (18.18%) were alcoholics. Family history of fragility fractures was present in 8%, and 18% patients had past history of a fragility fracture. Only 41% of our study population had adequate sun exposure. No significant difference was observed in the BMD of patients with or without adequate sunlight exposure and calcium and vitamin D supplementation, at the time of fracture [Table 3]. Haemogram, calcium profile, liver and renal function tests, were not significantly different among patients with normal BMD, osteopenia and osteoporosis. The medical co-morbidities like diabetes, hypertension and renal disease had no significant effect on the assessed parameters [Table 4].

### 5. Discussion

Our results show that fragility hip fractures are more common in women compared to men. Interestingly, mean age of fractures is lower in men compared to women. We have also shown that intertrochanteric fractures were most common site of hip fractures, in these patients. Our study also showed that VDD is highly prevalent (75%) in patients with fragility hip fracture but secondary hyperparathyroidism was observed in only 40% of patients.

An important finding from this study is a younger mean age of patients with fragility fractures which is approximately one decade earlier than the western population.<sup>10,13,14</sup> But, It is comparable with previous studies in Indian population.<sup>10,12,15,16</sup>

Prevalence of VDD was observed in 74.2% of patients, that is consistent with the findings of a similar study published by Dhanwal et al.<sup>10</sup> Vitamin D deficiency is a very common

**Table 2**

WHO Classification of osteoporosis.

WHO Category	Frequency	Percent
Normal	3	4.5
Osteopenia	10	15.2
Osteoporosis	41	62.1
Severe Osteoporosis	12	18.2
Total	66	100.0

**Table 3**  
Patient characteristics.

Parameters	Cases, n = 66	Male, n = 29	Female, n = 37	p value
Mean age (years)	67.6 ± 13.1	64.1 ± 13.8	70.3 ± 12.1	0.054
Smoker (%)	14(21.21)	12(41.3)	2(5.4)	0.08
Alcoholics (%)	12(18.18)	12(22.4)	0	0.112
Inadequate sun exposure (%)	39(59.09)	3(10.3)	36(97.3)	<0.001
Mean serum calcium (mg/dl)	8.7 ± 0.8	8.9 ± 0.8	8.5 ± 1.1	0.051
Mean serum phosphate (mg/dl)	3.8 ± 0.9	3.5 ± 0.6	4.1 ± 0.8	0.001
Mean serum ALP (U/l)	114.2 ± 57.5	114 ± 63.3	114.3 ± 53.5	0.984
Mean serum 25(OH) vitamin D (ng/ml)	9.87 ± 9.2	10.12 ± 9.5	9.67 ± 9.1	0.844
Vitamin D deficiency, n (%)	49(74.2)	21(72.4)	28(75.7)	0.764
Mean serum PTH (pg/ml)	89.13 ± 1.16	67.39 ± 3.78	106.18 ± 15.02	0.138
Secondary hyperparathyroidism, n (%)	27(40.9)	12(41.4)	15(40.5)	0.945
Mean BMD Hip (g/cm <sup>2</sup> )	0.622 ± 0.126	0.620 ± 0.221	0.624 ± 0.119	0.934
Mean BMD Spine (g/cm <sup>2</sup> )	0.848 ± 0.245	0.892 ± 0.307	0.815 ± 0.218	0.188

**Table 4**  
Number of patients suffering from medical co morbidities.

Disease	Diabetes		Hypertension		Renal Disease	
	No. of Patients	Percentage	No. of Patients	Percentage	No. of Patients	Percentage
Yes	19	28.8	16	24.2	5	7.6
No	47	71.2	50	75.8	61	92.4
Total	66	100.0	66	100.0	66	100.0

phenomenon all over the world. It is found to be more common in elderly home bound adults and is one of the important risk factors for an osteoporotic fracture.<sup>1,17</sup> So, whether an association exists between the incidence of such fractures and the deficiency of vitamin D has been a matter of exploration. The cause for such a high prevalence of vitamin D deficiency in present study might be multi-factorial. Inadequate dietary calcium and vitamin D intake, lack of food fortification with vitamin D, pigmented skin, environmental pollution and traditional dress code causing inadequate exposure to sunlight in most Indians, especially women.<sup>15</sup> Inadequate exposure to sun is observed in 59.09% of our patients with the 97.3% females lacking adequate sun exposure.

Prevalence of VDD in elderly hip fracture patients varies in different population. In the United States, a serum 25(OH) D level lower than 12 ng/ml was observed in 50% of women with osteoporotic hip fractures while in Italy this value was found to be 13.5%, with 21.6% of patients having a 25(OH) D level less than 20 ng/ml.<sup>2,17</sup> In a study from Japan, 62% of hip fracture patients had vitamin D insufficiency.<sup>3</sup> Very low levels of serum 25(OH) D were observed in inhabitants of Saudi Arabia, who tend to avoid sunlight and remain fully covered in outdoors, signifying the role of sunlight exposure and vitamin D levels.<sup>18</sup>

Vitamin D Deficiency also leads to secondary hyperparathyroidism that is a frequent disorder in hospitalized elderly, strongly correlated with the functional status, irrespective of gender and place of residence. About three fourths of hip fracture patients in India have vitamin D deficiency, and two thirds have secondary hyperparathyroidism.<sup>10</sup> The present study showed that 49% of the vitamin D deficient patients had secondary hyperparathyroidism. Some of the earlier studies showed no correlation between the 25-(OH)D and PTH in patients with hip fracture.<sup>19,20</sup>

Osteoporosis is observed in 80% of fragility hip fractures patients for comparison.

Calcium and Vitamin D nutrition play a pivotal role in determining the bone health and protection against tendency to fracture. Both calcium and vitamin D deficiencies are widely prevalent in urban and rural India.<sup>5–8</sup> VDD was observed in 74.2% of our patients with fragility hip fracture when compared to other studies.<sup>5–8,10</sup>

This study highlights the fact that majority of the patients sustain fractures at their residence (~74.2%) and more than half of the fractures are caused by a fall or slip in bathroom or wet floor. This finding needs special attention as the programs aimed towards prevention of fragility fractures amongst the elderly population should focus on this aspect. Special care and attention should be given to the elderly population by family members and caregivers in order to prevent in-house falls. Since most falls happen because of wet floors, family members should take precautions and proactive measures like dry floors, proper tiles and accompanying the patient. We recommend Calcium and Vitamin D supplementation specially in this high risk group with periodical serum analysis and DXA scans. Food fortification with vitamin D should be included in nutritional programmes specially for post menopausal females. 25(OH)D levels of greater than 30 ng/ml are needed for optimal calcium absorption and to ensure PTH suppression into the normal range and a oral dosage of 60000 IU per week or fortnight is the standard at our institute, since the long half life requires less frequent dosage.<sup>21,22</sup>

The present study assessed multiple parameters as a risk factor for fragility fractures many of which have not been done before. It included a sizeable number of patients and used scientific methods to reach the conclusions. Since most of the patients belonged to Northern India, so the sample size may not be representative of the whole country. This is because the results are based on patients who presented at our institute, which is visited mostly by patients of North Indian states like Punjab, Himachal Pradesh, Haryana, Uttar Pradesh, Bihar and Delhi, so outcomes may vary if other geographical regions are included. Geographical and cultural confounding factors like dietary habits, sunlight exposure at different regions, skin pigmentation might have existed as well.

This being a pilot study has certain limitations like small number of patients at a single centre and follow ups which were not analysed. However, we have taken detailed history and measured 25(OH)D and PTH of all the patients. So we recommend large scale studies with adequate number of patients to further substantiate our findings.

## 6. Conclusion

Prevalence of Vitamin D deficiency is very high in patients with hip fragility (proximal femur) fractures. The prevalence of secondary hyperparathyroidism is also high in such patients. Significant inverse correlation exists between intact PTH and 25-(OH)D levels in such patients who have a younger age group than Western population without any gender difference. Majority of the patients sustain in-house fractures. Patients with fragility fractures have a high prevalence of osteoporosis as well.

## Conflicts of interest

None.

## Source of funding

Nil.

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