



## BONE MINERAL DENSITY, CALCIUM AND VITAMIN D LEVELS IN ELDERLY PATIENTS WITH HIP FRACTURES

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### ABSTRACT

**Background:** Hip fractures are quite common in elderly population who generally have weak bones owing to osteoporosis. A relationship of vitamin D in calcium metabolism and bone health has also been reported. This study examines the relationship between bone mineral density, body mass index, serum calcium and vitamin D levels. **Methodology:** A total of 80 elderly hip fracture patients (>60 years) were enrolled in the study. Their demographic profile, personal habit profile, medical history, serum calcium and vitamin D levels were assessed. BMD was assessed sonographically. Data obtained was assessed using SPSS 21. **Results:** Mean age of patients was  $71.96 \pm 6.42$  years. Majority of the were females (71.75%). Mean BMI was  $20.78 \pm 3.27$  kg/m<sup>2</sup>. Majority (66.3%) had anemia. According to BMD, osteoporosis, osteopenia and normal bone density was seen in 20%, 70% and 10% patients. A total of 58 (72.5%) had hypocalcemia. Vitamin D insufficiency, deficiency and very severe deficiency was seen in 10%, 75% and 11.3% patients respectively. Older age, female sex, lower BMI, hypocalcemia and vitamin D deficiency were found to be significantly associated with lower BMD ( $p < 0.05$ ). A relationship between low vitamin D levels and serum calcium levels was also seen ( $r = 0.43$ ;  $p < 0.001$ ). **Conclusion:** Elderly hip fracture patients had a poor bone health which is related with increasing age, low BMI, low calcium and low vitamin D levels.

**KEYWORDS :** Elderly, hip fractures, vitamin D, serum calcium, bone mineral density.

### INTRODUCTION

Hip fracture is a quite common health-related problem in elderly. Evidence has shown that age has an exponential relationship with hip fracture incidence<sup>1</sup>. As per some recent studies, more than 90% of hip fractures occur in elderly patients aged 65 years or above<sup>2</sup>. Age-specific hip-fracture incidence in the Framingham study has shown the incidence to be 0.26 per 1000 person years and 0.27 per 1000 person years for women and men aged <60 years which continues to reach upto 15 per 1000 person years and 6.58 per 1000 person years respectively for women and men aged 80-84 years<sup>3</sup>. High increase in rate of hip-fractures with increasing age is attributable to two factors – viz. first, high susceptibility of elderly to fall and second, high prevalence of osteoporosis in elderly population<sup>4,5</sup>. Apart from these two major reasons, muscle weakness, functional limitations, environmental hazards, use of psychoactive medications also play a significant role in increasing susceptibility to hip fracture risk<sup>6</sup>.

The primary reason for osteoporosis among elderly is inadequate absorption and utilization of calcium. Vitamin D is vital for its dominant role in ensuring absorption and utilization of calcium<sup>6</sup>. Thus osteoporosis and vitamin D deficiency seem to be the two major risk-factors for hip fractures in the elderly. Hence, the present study was carried out to evaluate bone mineral density, calcium and vitamin D levels in elderly patients with hip fractures.

### MATERIAL AND METHOD

A total of 80 consecutive elderly hip fracture patients (>60 years) were enrolled in the study. Their demographic profile, personal habit profile, medical history, serum calcium and vitamin D levels were assessed. BMD was assessed sonographically.

Body mass index  $< 18.5$  kg/m<sup>2</sup> was defined as underweight,  $18.5$ – $24.9$  kg/m<sup>2</sup> as normal weight,  $25.0$ – $29.9$  kg/m<sup>2</sup> as overweight and  $\geq 30$  kg/m<sup>2</sup> as obese respectively.

Dual X-ray absorptiometry (DXA) analysis (Hologic QDR, 4,500 W) was used to measure bone density in the lumbar vertebral and femoral bone (femur neck, trochanter and Ward triangle). BMD status was determined as osteoporosis at T-score  $< -3$  SD. Osteopenia was defined as T-score  $< -2$  to  $-3$  SD while T-scores  $> -2$  SD were considered as normal.

The normal range for serum calcium was defined as 8.7 – 10.3

mg/dl. Hypocalcemia was defined as serum calcium level  $< 8.7$  mg/dl.

Vitamin D level was considered as normal at  $> 30$  ng/ml. Insufficiency, deficiency and very severe deficiency was defined at vitamin D level 20-30 ng/ml, 10-20 ng/ml and  $< 10$  ng/ml respectively.

**Data Analysis:** Data was analysed using Statistical Package for Social Sciences (SPSS) version 21.0. Chi-square test and ANOVA were used to compare the data. A correlation of BMD T-scores, Vitamin D levels, BMI and Serum calcium levels was done using Pearson's correlation coefficient ('r'). An 'r' value  $< 0.3$  was considered as weak correlation, 0.3-0.5 as mild correlation, 0.5-0.7 as moderate correlation and  $\geq 0.7$  as strong correlation. Confidence level of the study was 95% and 'p' value less than 0.05 was indicator of a significant association.

### RESULTS

A total of 80 elderly patients (>60 years of age) presenting with hip fractures were enrolled in the study. Age of patients ranged from 62 to 82 years. Mean age of patients was  $71.96 \pm 6.42$  years. Majority of them were females (71.75%). Body mass index of the patients ranged from 15.2 to 28.40 kg/m<sup>2</sup>. Majority of patients had BMI in normal weight category (55%) followed by underweight (27.5%) and overweight (17.5%) category. None of the patients had BMI in obese category. Past history of fracture was revealed by 15 (18.8%) patients. Prevalence of anemia, diabetes, hypertension, respiratory disease, heart disease and kidney disease was revealed by 53 (66.3%), 14 (17.5%), 18 (22.5%), 6 (7.5%) and 5 (6.3%) patients respectively. There were 11 (13.8%) patients who revealed a smoking history and 9 (11.3%) reported of alcohol use (Table 1).

**Table 1: Demographic Profile and Medical History of Elderly Hip Fracture Patients**

SN	Characteristic	No.	%
1.	Mean age $\pm$ SD (Range) years	$71.96 \pm 6.42$	(62-82)
2.	Sex		
	Male	23	28.25
	Female	57	71.75
3.	Body Mass Index (kg/m <sup>2</sup> )		
	Underweight ( $< 18.5$ )	22	27.5
	Normal weight (18.5-24.9)	44	55.0

	Overweight ( $\geq 25$ -29.9)	14	17.5
	Mean BMI $\pm$ SD (Range)	20.78 $\pm$ 3.27	(15.2-28.40)
4.	Past history of fracture	15	18.8
5.	Anemia	53	66.3
6.	Diabetes	14	17.5
7.	Hypertension	18	22.5
8.	Respiratory disease	22	27.5
9.	Heart disease	6	7.5
10.	Kidney disease	5	6.3
11.	Smoking	11	13.8
12.	Alcohol	9	11.3

Only 8 (10%) patients had normal bone mineral density. Osteopenia and osteoporosis were diagnosed in 56 (70%) and 16 (20%) patients respectively. Majority of patients (72.5%) had hypocalcemia. Only 3 (3.8%) patients had vitamin D levels in normal range. A total of 8 (10%) had insufficiency, 60 (75%) had deficiency and 9 (11.3%) had very severe deficiency (Table 2).

**Table 2: BMD, Hypocalcemia and Vitamin D Deficiency Status**

SN	Characteristic	No.	%
1.	BMD Status		
	Osteoporosis (T Score < -3SD)	16	20.0
	Osteopenia (T score < -2 to -3SD)	56	70.0
	Normal (T score > -2 SD)	8	10.0
2.	Serum Calcium levels		
	Normal (8.7-10.3 mg/dl)	22	27.5
	Hypocalcemia (<8.7 mg/dl)	58	72.5
3.	Vitamin D status (ng/ml)		
	Normal (>30 ng/ml)	3	3.8
	Insufficiency (20-30 ng/ml)	8	10.0
	Deficiency (10-20 ng/ml)	60	75.0
	Very severe deficiency (<10 ng/ml)	9	11.3
	Mean Vit. D $\pm$ SD (Range) ng/ml	14.90 $\pm$ 5.48	(7.80-34.50)

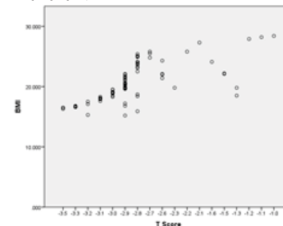
Mean age of patients with osteopenia was significantly higher as compared to that of patients with normal BMD or osteoporosis ( $p=0.024$ ). Females, as compared to males had significantly higher proportion of osteopenia and osteoporosis ( $p=0.001$ ). Mean BMI of patients with normal BMD status was maximum whereas that of osteoporosis was minimum. Statistically, there was a significant association between increasing BMI and normalizing BMD status ( $p<0.001$ ). No association of BMD status was seen with history of fractures though they showed an incremental trend from normal to osteoporosis. History of anemia, diabetes, hypertension, respiratory illness, heart disease and kidney disease also did not show a significant association with BMD status. No significant association of smoking or alcohol use was observed with BMD status. Prevalence of hypocalcemia was significantly higher in osteoporosis (81.3%) as compared to those with osteopenia (76.8%) and normal BMD (25%) respectively ( $p=0.006$ ). Prevalence of vitamin D deficiency/very severe deficiency was 100%, 90.1% and 25% respectively in those with osteoporosis, osteopenia and normal BMD status respectively ( $p<0.001$ ) (Table 3).

**Table 3: Association of Bone Mineral Density Status with different Demographic and Clinical Factors**

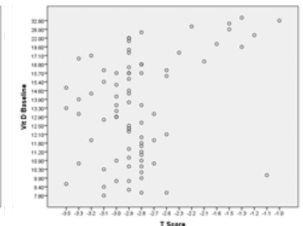
SN	Variable	Osteoporosis (n=16)	Osteopenia (n=56)	Normal (n=8)	Statistical significance
1.	Mean age $\pm$ SD (Years)	68.63 $\pm$ 5.68	73.21 $\pm$ 6.40	69.88 $\pm$ 5.52	F=3.923; $p=0.024$
2.	Sex				
	Male	7 (43.8%)	10 (17.9%)	6 (75.0%)	$\chi^2=13.355$ ; $p=0.001$

	Female	9 (56.3%)	46 (82.1%)	2 (25.0%)	
3.	Mean BMI $\pm$ SD (kg/m <sup>2</sup> )	17.11 $\pm$ 0.83	21.38 $\pm$ 2.74	23.90 $\pm$ 3.91	F=22.71; $p<0.001$
4.	H/o fractures	5 (31.3%)	9 (16.1%)	1 (12.5%)	$\chi^2=2.110$ ; $p=0.348$
5.	Anemia	12 (75.0%)	35 (62.5%)	6 (75.0%)	$\chi^2=1.174$ ; $p=0.556$
6.	Diabetes	2 (12.5%)	11 (19.6%)	1 (12.5%)	$\chi^2=0.594$ ; $p=0.743$
7.	Hypertension	1 (6.3%)	15 (26.8%)	2 (25.0%)	$\chi^2=3.041$ ; $p=0.219$
8.	Respiratory illness	3 (18.8%)	17 (30.4%)	2 (25.0%)	$\chi^2=0.869$ ; $p=0.648$
9.	Heart disease	0	5 (8.9%)	1 (12.5%)	$\chi^2=1.750$ ; $p=0.417$
10.	Kidney disease	1 (6.3%)	4 (7.1%)	0	$\chi^2=0.610$ ; $p=0.737$
11.	Smoking	4 (25.0%)	7 (12.5%)	0	$\chi^2=3.057$ ; $p=0.217$
12.	Alcohol	4 (25.0%)	4 (7.1%)	1 (12.5%)	$\chi^2=3.988$ ; $p=0.136$
13.	Hypocalcemia	13 (81.3%)	43 (76.8%)	2 (25.0%)	$\chi^2=10.18$ ; $p=0.006$
14.	Vitamin D status				$\chi^2=39.39$ ; $p<0.001$
	Normal	0	0	3 (37.5%)	
	Insufficiency	0	5 (8.9%)	3 (37.5%)	
	Deficiency	13 (81.3%)	45 (80.4%)	2 (25.0%)	
	Very severe deficiency	3 (18.8%)	6 (10.7%)	0	

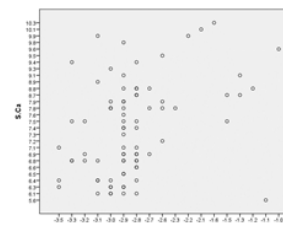
There was a moderate positive and significant correlation of BMD T-scores with BMI and vitamin D levels ( $r=0.59$  and  $0.61$ ;  $p<0.001$ ). A mild positive and significant correlation of BMD T-scores was also observed with S. calcium levels ( $r=0.37$ ). Vitamin D levels also showed a mild positive and significant correlation with serum calcium ( $r=0.43$ ) ( $p<0.001$ ) (Fig. 1a,b,c,d).



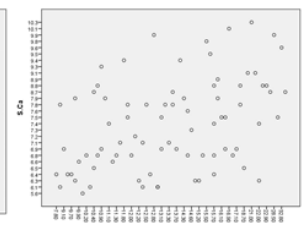
(a) Correlation between T-score and BMI ( $r=0.59$ ;  $p<0.001$ )



(b) Correlation between T-score and Vitamin D levels ( $r=0.61$ ;  $p<0.001$ )



(c) Correlation between T-score and S. calcium levels ( $r=0.37$ ;  $p<0.001$ )



(d) Correlation between Vitamin D and S. calcium levels ( $r=0.43$ ;  $p<0.001$ )

**Fig. 1: Correlation of T-score with (a) BMI, (b) Vitamin D and (c) S. calcium; (d) Correlation between S. calcium and Vitamin D levels**

## DISCUSSION

The present study showed a high prevalence of osteopenia (70%) and osteoporosis (20%) among elderly patients with hip fractures. The study also found a high prevalence of hypocalcemia (72.5%) and vitamin D deficiency/severe deficiency (86.3%). Compared to present study, Nataraj et al.<sup>6</sup> in their study found prevalence of osteopenia and osteoporosis in 41.5% and 26.8% of elderly patients with hip fracture. In their study, 31.7% patients had normal BMD status. However, in their study vitamin D deficiency was seen in only 22% patients while 36% had vitamin D insufficiency and 41% had vitamin D levels in normal range. In another study, Wang et al.<sup>7</sup> in their study reported prevalence of osteoporosis to be 40%. They also reported a vitamin D insufficiency and deficiency in 38/60 (63.3%) of their elderly patients with hip fractures. Compared to the present study, these studies had lower prevalence of both impaired BMD status as well as vitamin D deficiency.

In the present study, we also found a high prevalence of hypocalcemia (72.5%). Association of calcium deficiency and osteoporosis with hip fracture risk has been well documented<sup>8,9,10</sup>. The findings of the present study simultaneously showed the presence of both the abnormalities in a high proportion of elderly patients with hip fractures. In the present study we also found a significant association of BMD status with calcium levels and vitamin D levels. Wang et al.<sup>7</sup> too in their study found prevalence of vitamin D deficiency/insufficiency to be significantly higher in elderly hip fracture patients with osteoporosis (80%) as compared to those without osteoporosis (50%). However, Nataraj et al.<sup>6</sup> in their study failed to find this association to be significant. But Chapuy et al.<sup>11</sup> in their study found that vitamin D3 and calcium help to prevent hip fractures in elderly women, thus highlighting the relationship of fracture susceptibility (owing to decreased BMD) with vitamin D3 and calcium. In the present study, we found mild to moderate positive correlation of bone mineral density T-scores with body mass index, vitamin D levels and serum calcium levels. We also found a mild positive correlation between vitamin D and serum calcium levels which tries to explain the physiological basis of preventive role of vitamin D and calcium levels in prevention of hip fractures as shown by Chapuy et al.<sup>11</sup> in their study. In another study, Heckman et al.<sup>12</sup> also showed that vitamin D helps to improve the BMD status among elderly. Another study in Spanish adults<sup>13</sup> also showed an interrelationship of BMD status with serum vitamin D and calcium levels. Similar to the present study, they also showed a significant positive correlation between vitamin D levels and serum calcium levels. The findings of the present study, thus highlight the significance of vitamin D levels in the absorption of calcium which in turn might be helpful in reducing the risk of osteoporosis and subsequent risk of hip fractures in the elderly.

## CONCLUSION

Elderly hip fracture patients have a high prevalence of osteopenia, osteoporosis, vitamin D and calcium deficiencies. The findings of the study suggest that deficiency of vitamin D might influence the calcium absorption which may subsequently lead to loss of bone mineral density and may increase the susceptibility to hip fracture.

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