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ORIGINAL RESEARCH

An observational study on the relationship between vitamin D level and hip fractures

[1]Dr Virender Singh Kadyan, [2]Dr Karan Alawadhi

[1]HOD, [2]Senior Consultant, Department of Orthopaedics, Malik Hospital Hansi, Haryana, India

Correspondence:
Dr Karan Alawadhi
Senior Consultant, Department of Orthopaedics, Malik Hospital Hansi, Haryana, India

Abstract

Introduction: Vitamin – D deficiency greatly promotes the chances of muscle weakness ad pain that could possibly lead to reduction in power and function, increased bone turnover and increased risk of falls and fractures of the hip in elderly.Hence the aim of this study is to assess the relationship between vitamin D level and hip fracture.

Materials and Methodology: Of the 170 remaining patients evaluated had serum taken for further analysis (mean age 77.8, SD 10 years; 75.6% females). The mean age of female patients was 78.42 (SD 11) years and the mean age of males was 75.8 (SD 9.9) years. Fasting early morning venous blood was collected from patients for the serum measurement. Samples were instructed to be stored at -20°C. Serum samples were obtained at the time of fracture with samples within 24 hours of the event and therefore it is less likely to be affected by the fracture event which recognises a transient rise in serum calcium.

Results: Of the 170 participants that were assessed over the study period of 12 months, mean age of the participants was 77.8 (± 10) years, with the mean age of females being 78.42 (± 11) years and the mean age of males being 75.8 (± 9.9) years. 71 (41.7%) participants had a previous fracture at the time of the presentation with a hip fracture in this study. 29 (17.4%) participants were on vitamin D supplementation at the time of fracture.

Conclusion: Hypovitaminosis D is reportedly common among the older patients with hip fractures but remains slightly diminished than its prevalence that has been reported in western countries. Although not very randomly linked to activity of daily life, it was related with higher risks of earlier falls and cognitive impairment both of them in turn that increases the chances for the risk of fractures.

Keywords: vitamin – D, hypovitaminosis, falls, hip fracture

Introduction

As elaborated in the earlier studies, elderly people are at a relatively greater risk of vitamin D deficiency because of the associated risk factors like (1) very minimal sunlight exposure and lower cutaneous synthesis of vitamin D, (2) decreased dietary intake of D2 (ergocalciferol) and D3 (cholecalciferol), (3) deficient intestinal absorption and (4) impaired hydroxylation in the liver and kidneys.[1] Since the deficiency of vitamin – D is more commonly associated with the increased muscle weakness and pain which might ultimately lead to reduced strength, balance and function.[2,3] The reported prevalence of vitamin D deficiency is even higher in elderly patients with fragility fractures that may relatively varying from 55% to 91.6%.[4,5]

There were several studies that majorly suggest that the average daily administration of 700-800 IU vitamin D greatly diminishes the risk of hip fractures in the elderly.[6,7] A meta-analysis with double blinded randomised controlled trials conducted in comparing vitamin D

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supplementation with or without calcium versus calcium alone or placebo, observed that a 26% reduction in the relative risk of hip fracture in individuals aging more than or equals to 60 years who are receiving 700-800 IU of vitamin D daily.[4]

Many observational studies quite possibly fail to detect a dependent relationship between vitamin D levels and frailty, while there were only few interventional studies that could possibly yield a positive effect of vitamin D supplements on frailty, mainly due to the enhancement in the physical performance parameters.[8,9] Falls are reported to be a major component in risk of getting a fracture and fall prevention is a core part that plays major role in the management of patients with fragile bones. The prevalence of falls increases with advancing age and is reported to be higher in females than in males.[10] Falls are aunavoidable risk factor in hip fractures. 95% of hip fractures are related with a fall, with 10% of falls being associated with a fracture.[6] There have been many studies that could possibly demonstrate the benefit of vitamin D in preventing falls.[8] This protective mechanism is considered to be associated with the improvements in muscle strength, as well as its direct effect on bone. Hence the aim of this study is to assess the relationship between vitamin D level and hip fracture.

Materials and methodology

One hundred and seventy-two subjects were reported to be sustained a low trauma hip fracture. Two patients were excluded as they did not have a serum 25(OH)D level taken as both patients were reported dead in the pre-operative period itself. Of the 170 remaining patients evaluated had serum taken for further analysis (mean age 77.8, SD 10 years; 75.6% females). The mean age of female patients was 78.42 (SD 11) years and the mean age of males was 75.8 (SD 9.9) years. Informed consent was taken from all the patients or their guardians who were participating in this study protocol. Patients with a significant history of trauma or a history of metastatic carcinoma were relatively excluded.

Admission records were promptly reviewed on a routine daily basis with all patients being consented to physical examination and blood tests pre-operatively. The pathological hip fractures that were reported due to primary or metastatic bone cancer, multiple myeloma and Paget's disease of bone were also been excluded. The study protocol was structurally designed and was promptly approved by the local ethics committee.

All blood tests for serum 25(OH)D and PTH measurements were taken during acute care within 24 hours after the hip fracture event. Blood sampling was performed in order to analyse parathyroid hormone (PTH), 25-hydroxyvitamin - D, serum creatinine, calcium, phosphate, albumin and alkaline phosphatase levels. Fasting early morning venous blood was collected from patients for the serum measurement. Samples were instructed to be stored at -20°C. Serum samples were obtained at the time of fracture with samples within 24 hours of the event and therefore it is less likely to be affected by the fracture event which recognises a transient rise in serum calcium. Continuous variables are expressed as mean ± standard deviation (SD) as well as median for parameter not normally distributed. A 0.05 level of significance was used throughout the study to predict the statistical significance.

Results

Of the 170 participants that were assessed over the study period of 12 months, mean age of the participants was 77.8 (± 10) years, with the mean age of females being 78.42 (± 11) years and the mean age of males being 75.8 (± 9.9) years. 71 (41.7%) participants had a previous fracture at the time of the presentation with a hip fracture in this study. 29 (17.4%) participants were on vitamin D supplementation at the time of fracture. Characteristics of the study group are précised in table 1.

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 07, 2022

Table 2 shows that 25(OH)D according to vitamin D supplementation group and pre-admission residence. Patients admitted from a nursing home had a lower serum vitamin D level compared to community dwellers (p=0.096). Non-supplemented patients admitted from a nursing home had significantly lower levels of serum 25(OH)D.

The Table 3 displays the distribution of vitamin D levels within the study group. Severe vitamin D deficiency below 20 nmol/L was identified in 30.2% and below 50 nmol/L was identified in 67.5% of the overall group of patients. A greater percentage of male patients had serum vitamin D below 50 nmol/L compared to females (79% and 63.8%, respectively). 4.5% of non-supplemented patients achieved an optimum level of serum vitamin D (>75 nmol/L). 36.6% of supplemented patients had a vitamin D level below 50 nmol/L.

Table 1: Baseline characteristics of study group (n=156).

Parameters	
Mean age (years)	77.8 ± (10)
Female (n=123)	78.42 ± (11)
Male (n=47)	75.8 ± (9.9)
Prior fracture history	71 (41.7%)
Previous hip fracture	12 (7.2%)
Vit – D supplementation	29 (17.4%)

Table 2: Comparison of baseline characteristics between (1) supplemented and non-supplemented patients and between (2) type of residence prior to admission. SD: Standard deviation. 25(OH)D: 25-hydroxyvitamin D. PTH: Parathyroid hormone.

Parameters	Vitamin – D supplementation		P – value
	Non-supplemented (n=132)	Supplemented (n=38)	
Age (years)	77.6 ± (10)	78.8 ± (10)	0.552
Gender (% females)	72.5	92.5	0.031
Previous fracture (%)	36.7	65.7	0.008
25 (OH)D (nmol/L)	35.3 ± (25.3)	65.6 ± (24.5)	0.001
Non-supplemented	-	-	-
Supplemented	-	-	-
25(OH)D levels			
<50 nmol/L n(%)	97 (73.6)	36 (26.4)	-
50 – 75 nmol/L n(%)	29 (21.7)	13 (33.5)	-
>75 nmol/L n(%)	6 (4.9)	11 (29.9)	-

Table 3: Distribution of Vitamin D Levels in subgroups of patients

Vit – D level nmol/L	Patients (n=170)	Females (n=123)	Males (n=47)	Non-supplemented (n=132)	Supplemented (n= 38)
<20 nmol/L n(%)	51 (30.2)	36(29)	17(36.9)	48(36.6)	0
<50 nmol n(%)	115 (67.5)	78(63.8)	37(79)	97(73.8)	14(38)
50 – 75 nmol/L n(%)	41(23.9)	32(26.5)	7(15.9)	29(21.9)	13(33.3)
>75 nmol/L n(%)	17(10)	13(10.3)	2(5.3)	6(4.5)	11(29.6)

Discussion

In this sample of 170 consecutive patients with hip fracture, there was a reported to be higher prevalence of vitamin – D deficiency [25(OH)]D<50 nmol/L in those patients who were

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admitted in hospital with a hip fracture.16.7% of patients were on any vitamin D supplementation at the time of fracture and 10.3% of patients were on the recommended on the 800IU per day according to guideline recommendations. Consequently, 25(OH)D serum concentrations were low in all subgroups with a high prevalence of severe vitamin D deficiency (<20 nmol/L) in 33% of individuals admitted from the community and 23% of individuals admitted from nursing home.[11,12]

Various studies suggested that an increased serum PTH concentration observed in elderly people with or without hip fracture associated with vitamin D deficiency.[13] In this study, serum PTH correlated with levels of serum 25(OH)D, with higher levels of PTH being observed in those with lower vitamin D levels. Some studies have reported that patients with the highest levels of PTH post hip fracture have poorer outcomes.[12] Patients observed with an elevated PTH when compared to those with serum PTH in the normal range have a 15 times greater risk of experiencing the mortal outcome and increased hospital admission followed by.[14] Patients with hypovitaminosis D and secondary hyperparathyroidism compared to those without elevated PTH levels have increased bone turnover,[6] increased fracture risk[12] and a higher mortality rate, especially due to cardiovascular deaths.[15] Secondary hyperparathyroidism should be considered as a potential risk factor for poor outcomes and should be managed effectively.

Management of vitamin D deficiency not only saves the bone and muscle strength but also majorly prevents falls and fractures.[1] Falls are a major component in non-vertebral fracture risk that majorly include hip fractures. The low levels of 25(OH)D have been directly attributed to frailty and poor health status, which could possibly contribute to a positive relation with fractures.[12]Manyresearches have correlated the benefit of supplemental vitamin D3 in preventing hip fractures. And almost over 2 decades ago, *Chapuy* and *Meunier*[16]displayed the benefit of 1200 mg calcium and 800 IU vitamin D3 in greatly minimising the risk of hip fractures by 43% and the risk of non-vertebral fractures by 32% in institutionalised patients. The mechanism by which vitamin D minimises falls is considered to be through improvement of muscular strength and function.

We observed that 1 in 6 (17.4%) of all patients were on vitamin D supplementation at the time of admission in the study group, with 10% of all the study group taking a recommended dose of 800 IU of cholecalciferol (Vitamin D3). A substantial portion of patients (41.7%) had a reportedly previous history of fracture at the time of admission. Previous fractures are a potent risk factor for having a hip fracture – this is particularly true for wrist and vertebral fractures.[17] There is much confusion on the optimum level of serum vitamin D [25(OH)D]. The International Osteoporosis Foundation (IOF) have published recommendations for the optimal serum 25(OH)D level to be above 75 nmol/L.3 This serum established the 25(OH)D level based on the maximal PTH suppression, diminished rate of bone loss and falls to optimise the quantum of bone health. The dose of vitamin D supplementation required by a patient would depend on several factors including the baseline level of serum 25(OH)D, body mass index, sun exposure and vitamin D metabolism. For individuals with effective sunlight exposure, a dose of 800 IU/day vitamin D3 may be suffice. Patients with obesity, a history of falls, known osteoporosis and limited sun exposure may require higher doses of vitamin D3 up to 2000 IU/daily.[3] In our study, less than a third of the study patients achieved an optimal level of vitamin D on 800 IU vitamin D3 /day which is the recommended daily intake of vitamin D.

Conclusion

Hypovitaminosis D is reportedly common among the older patients with hip fractures but remains slightly diminished than its prevalence that has been reported in western countries. Although not very randomly linked to activity of daily life, it was related with higher risks of

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 07, 2022

earlier falls and cognitive impairment both of them in turn that increases the chances for the risk of fractures.

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