Impact of Frailty in Non-Surgical Fractures in Elderly Population with Vitamin D Deficiency: How Much Is Little?

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Abstract

Vitamin D is associated to bone health and reduction in the incidence of fractures. However, this condition remains increasing specially during elderly, predisposing to frailty and increasing hospital stay days. The reduction in vitamin D levels could explain the high incidence of fractures as well as mortality. This is an observational transversal retrospective study. This study aimed to determine the relation between frailty and fractures in patients with low vitamin D levels. We found 914 patients with vitamin D levels; however, we included just 319 patients who had previous imaging study, vitamin D determination, and confirmed diagnosis of frailty. Patients with surgical fractures, chronic kidney disease or vitamin D supplementation were excluded from this study. The main fractures related to long hospital stay (> 5 days), frailty, and low vitamin D levels were clavicle fracture; however, scaphoids fracture was related to shorter hospital stay and higher vitamin D levels. Most of fractures happened over 60 years old in women and under 60 years old in men. Vitamin D deficiency was related to long hospital stay in all fractures, despite the deficiency, vitamin D levels over 12 ng/mL were related to better outcomes in all patients; however, serum vitamin D levels related to the incidence of fracture were lower than reported in literature.

Keywords: vitamin D, frailty, deficiency, fractures, hospital stay
Introduction

Low calcium and phosphorus serum levels plus vitamin D deficiency are related to fractures at all ages, and osteomalacia is the main condition found in these patients. Vitamin D levels are lower in adults, mainly among elderly and during winter seasons, increasing the incidence of fractures. Despite this is the main risk population, frailty contribute to fractures. A fragility fracture is produced for low impact trauma as falls and osteoporosis play an important role in fragility fracture (MacLaughlin & Holick, 1985).

According to the National Academy of Medicine (NAM), the optimal serum levels of 25 (OH) D are required between 20 and 40 ng / ml to maintain a good bone health; when these levels are below 20 ng / ml, complications as fractures happens. In elderly, the US Geriatric Society (UGS) recommends levels over 30 ng/mL to avoid these complications and prevent fractures (American Geriatrics Society Work-group on vitamin D Supplementation for Older Adults, 2014). The optimal levels of vitamin D are obtained with a maximum parathyroid hormone suppression and an adequate intestinal absorption of calcium, decreasing the incidence of fractures (Binkley et al., 2017).

Poor sunlight exposure, immobility, or sensory alterations in elderly decrease vitamin D serum levels, so this population must be supplemented to maintain optimal vitamin D levels and prevent fractures, recommending an intake of 600-800 UI of vitamin D3 (Colecalfiverol) (Gloth et al., 1995). A reduction of intake or absorption is the main causes of vitamin D deficiency; however, other causes as poor sunlight exposure, hepatic diseases, increased hepatic degradation, drugs as phenytoin must be avoided to prevent deficiency (Wortsman et al., 2003). Vitamin D, phosphorus and calcium deficiency lead to hyperparathyroidism, phosphaturia and bone demineralization, leading to osteomalacia, a condition that happens in chronic kidney disease (CKD) patients (Gómez de Tejada Romero et al., 2011).

Every 100 IU of vitamin D3 increases serum concentrations of 25 hydroxyvitamin D between 0.7 to 1 ng/mL (Sanders et al., 2010). Moreover, some meta-analysis suggest that vitamin D compared to placebo does not reduce the risk of fractures; however, it has been demonstrated that a dose of 400 UI of vitamin D reduces hip fractures (Weaver et al., 2016). The main risk factors to develop fractures are elderliness specifically being 50 years old, loss of bone mass density, structural alterations, and falls and require supplementation to reduce fracture and osteoporosis risk (Weaver, 2014).
Patients with osteomalacia must be supplemented with calcium and phosphorus to normalize vitamin D levels, leading the expression of receptor on cell surface (Masuyama et al., 2003). This is an indirect biomarker of bone loss because the high levels of vitamin D and metabolites, the less bone mineral density (Ebeling et al., 2001). A loss of vitamin D stimulation leads to hypocalcemia and osteomalacia, but a reduction in this stimulation leads to an increase in Parathormone (PTH), increasing bone and calcium resorption, normalizing serum calcium levels, and keeping bone mineralization (Need et al., 2008).

Serum vitamin D levels lower than 15 ng/mL reduce the 1,25(OH)2D and intestinal calcium absorption, increasing alkaline phosphatase (ALP), so maintaining levels from 30 to 50 ng/mL led PTH compensates the low vitamin D without bone resorption (Gallagher et al., 2012).

This is one of the main risk factors to fractures; however, another factors as frailty, loss bone mass, and structural bone changes produce osteoporotic fractures, and the hip fracture is the main fracture involved (Ensrud, 2013). Although these factors contribute to frailty, muscle strength is an important factor to prevent fractures; however, vitamin D has a good effect on muscle strength, although there are not beneficial changes increasing muscle mass (Beaudart et al., 2014). It is known that vitamin D promotes calcium resorption, bone mineralization and muscle strength, so the main clinical and biochemical features of vitamin D deficiency are secondary hyperparathyroidism, loss of bone mass, and weakness. (Holick, 2007). On the literature, there is just a study which mentions a beneficial effect on administration of vitamin D; however, this study mentions that a combination of vitamin D plus calcium prevent fractures in osteoporotic patients; however, there is no beneficial effect on patients with current fracture (Tang, 2007).

**Methods**

This is an observational transversal retrospective study that was done during the period from April 2020 to January 2022. We included patients with fracture evidenced by imaging study, measure of serum vitamin D levels at most 1 month later or 1 month previous from fracture, patients with non-surgical criteria, patients over 18 years old, and not supplemented with calcium, phosphorus or vitamin D analogs. Frail criteria were used to identify frailty patients. We excluded patients with history of supplementation, without vitamin D levels measured, history of CKD, mineral bone disorders,
parathyroid disorders, gastrointestinal disorders, use of phosphorus, calcium, magnesium, potassium or sodium drugs interactors. Medians were compared using a bivariate correlation of continuous variable, linear regression, a Pearson correlation (r) and Kruskal Wallis were performed. All analyses were done using SPSS 20.0 (SPSS, Inc., Chicago, IL, USA).

Results

A total of 914 patients had previous fracture during the period of January 2016 to December 2021; just 319 patients had previous imaging study and vitamin D determination. There were 194 women (60.81%) from 62-68 years old and 125 men (39.19%) from 54-61 years old. Two hundred five patients (64.2 %) had frailty diagnosis. Vitamin D levels in females were from 15.7 to 19.65 ng/mL while the vitamin D levels in men were 15.8 to 18.6 ng/mL. Days of hospital stay in fracture of scaphoids (0-3 days), femur (7-10 days), clavicle (5-12 days), knee (3-8 days), thoracic (5-10 days), skull (2-8 days), lumbar (5-10 days), and calcaneus (1-7 days) are shown in Figure 1; the days until hospital discharge were higher in clavicle fracture, compared to scaphoid fracture, requiring less time until hospital discharge. On the other hand, vitamin D levels in fracture of scaphoids (14.2 to 22.3 ng/mL), femur (2.69 to 34.1 ng/mL), clavicle (3.1 to 31.8 ng/mL), Knee (6.4 to 34.5 ng/mL), thoracic (4.5 to 38.6 ng/mL), skull (7.8 to 32.3 ng/mL), lumbar (5.39 to 32 ng/mL), and calcaneus (4.8 to 23.5 ng/mL) are shown in Figure 2, displaying lower levels in femur and clavicle fractures compared to scaphoids, with higher vitamin D levels. The linear regression analysis showed no relation between vitamin D levels and hospital stay days in all fractures in patients over 65 years old and above 65 years old (R = 0.23, R^2= 0.01, p 0.087).
Figure 1. *Intervals plot with the number of patients according to fractures relating days of hospital stay.*

Figure 2. *Box plot with the number of patients and fractures related to days of hospital stay, minimum and maximum vitamin D levels according to each fracture.*
Conclusion

The vitamin D levels in most of patients with fractures lead to insufficiency and deficiency, especially in frailty patients; however, levels were lower in men compared to women. All fractures are more often in men above 60 years old, and women over 60 years old. Moreover, clavicle fractures had lowest vitamin D levels and require more hospital stay days. On the other hand, scaphoid fracture had higher vitamin D level, requiring less hospital days until hospital discharge. Levels higher than 12 ng/ml were related to a shorter hospital stay; however, these ranges differ in patients during hospitalization. Vitamin D levels over 12 ng/mL were favorable in patients with fracture; however, these are not optimal vitamin D levels, and these ranges must be individualized. Although Vitamin D is involved into mineral bone disorders, the vitamin D serum levels, at the time of presentation of fracture did not reflect the time since those levels were reduced. It just reflected how these levels were at the point of fracture. Despite the poor sunlight exposure, immobility and lower intake of vitamin D, the risk of fractures remains, so it is recommended to maintain optimal vitamin D levels and prevent fractures, recommending an intake of 600-800 UI of vitamin D3 (Colecalciferol).
References


