



OPEN ACCESS

This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

¹ Baylor College of Medicine, Houston, Texas, USA
² Saint Joseph's University Medical Center, Paterson, New Jersey 07503, USA

Correspondence to:

Todd P. Pierce,
 toddpierce47@gmail.com

Additional material is published online only. To view please visit the journal online.

Cite this as: Pierce TP, Issa K, Wright C, Scillia AJ, Emami A, and McInerney VK. Incidence of Vitamin D Deficiency and Insufficiency in Those with Hip Fractures: A Prospective Cohort Study. Premier Journal of Science 2024;1:100002

DOI: <https://doi.org/10.70389/PJS.100002>

Received: 20 July 2024

Revised: 13 August 2024

Accepted: 19 August 2024

Published: 12 October 2024

Ethical approval: Institutional Review Board

Consent: Informed consent documented

Funding: No industry funding

Conflicts of interest: N/a

Author contribution: Todd P. Pierce – Conceptualization, data acquisition, data curation, formal analysis, writing – original draft, review and editing

Guarantor: Todd P. Pierce

Provenance and peer-review: Unsolicited and externally peer-reviewed

Data availability statement: Not available

Incidence of Vitamin D Deficiency and Insufficiency in Those with Hip Fractures: A Prospective Cohort Study

Todd P. Pierce, M.D.¹, Kimona Issa, M.D.², Craig Wright, M.D.², Anthony J. Scillia, M.D.², Arash Emami, M.D.², and Vincent K. McInerney, M.D.²

ABSTRACT

INTRODUCTION

As the rise in the population over the age of 65 years continues, there is a concern that there will be an increase in fragility hip fractures. Inadequate vitamin D levels could affect the health of the bone, and subsequently increase of sustaining a hip fracture. The purpose of our study was to determine if there was in fact an association between insufficient or deficient vitamin D levels and sustaining a hip fracture in our patients 90 years of age or older.

METHODS

25-hydroxy vitamin D levels in all patients who presented to the Emergency Department of a high-volume teaching institution who also had a diagnosis of hip fracture from 2017 to 2019 were prospectively and randomly assessed. Vitamin D levels were randomly ordered and assessed by the on-call orthopedic resident on all patients over 90 years of age. Overall, 47 patients that were 90 years of age or older were treated in our institution of which the study cohort consisted of 47 patients. This included 7 men and 40 women with a mean age of 94 years (range, 90 to 102 years). The guidelines of the Endocrine Society definitions of Vitamin D deficiency, insufficiency, and normal levels were used. The incidence of vitamin D deficiency and insufficiency was compared to those with normal levels for statistical significance. Outcomes were further sub-stratified by gender.

RESULTS

The cohort had mean Vitamin D levels of 27.2 ng/ml (range, 4.3 to 69.4 ng/ml). Sixty-four percent of patients had lower than normal Vitamin D levels ($p = 0.007$) with 43% ($n = 20$) who were deficient and 21% ($n = 10$) who were considered insufficient. When outcomes were stratified by gender, men and women had similar mean vitamin D levels ($p = 0.67$). Women with hip fractures had higher incidences of vitamin D levels of <30 ng/mL ($p = 0.002$) while men had similar incidences ($p = 0.6$) of vitamin D levels above and below 30 ng/mL.

DISCUSSION

We found an association between the incidence of hip fractures and increased incidence of insufficient or deficient levels of vitamin D those over 90 years of age. Future studies should examine how improvements in vitamin D levels can reduce potential risk of fragility hip fractures.

Keywords: Vitamin D deficiency, Hip fractures, Elderly patients, Gender differences, Fragility fractures

Introduction

As the rise in the population over the age of 65 years continues, there is a concern that there will be an increase in fragility fractures, more specifically hip fractures. It is projected that by 2050 the incidence of hip fractures will approximate 6.3 million annually compared to 1.7 million in 1990.¹⁻³ Hip fractures carry high mortality rate where it is estimated that 27% of patients who experience hip fracture die within 1-year follow up.⁴ Multiple factors have been associated with increased risk of hip fractures in the elderly including white race, female gender, and previous hip fracture.^{3,5}

It is well established that vitamin D plays a critical role in healthy bone development. However, there is a paucity of literature evaluating the potential correlation between inadequate vitamin D levels and subsequent increase of sustaining a hip fracture in the nonagenarian population. As the incidence of fragility fractures continue to increase in such population, it becomes important to conduct more studies that optimize fractures prevention strategies by evaluating the utility of vitamin D levels as a hip fracture predictor tool.^{4,6}

The purpose of this study is to evaluate vitamin D levels by assessing: (1) the association between vitamin D levels and the incidence of sustaining a hip fracture in patients 90 years of age or older and (2) demographic characteristics by comparing the effects of vitamin D levels on the incidence of hip fractures between males and females of the same population.

Methods

Appropriate Institutional Review Board approval was sought and obtained prior to the initiation of this study. 25-hydroxy vitamin D levels were randomly ordered and assessed by the on-call orthopedic resident on patients over 90 years of age who had presented to the Emergency Department of a high-volume teaching institution with a diagnosis of hip fracture from 2017 to 2019. Hip fracture was defined as presence of either a femoral neck fracture, intertrochanteric, or subtrochanteric femur fracture.

Overall, 87 patients that were 90 years of age or older were treated in our institution of which the study cohort consisted of 47 patients while the remaining 40 patients were excluded because no vitamin D values were available for them. This cohort included 7 men and 40 women with a mean age of 94 years (range, 90 to 102 years). Based on the guidelines of the Endocrine Society in defining vitamin D deficiency, patients were further sub-stratified as being vitamin D deficient (<19.9 ng/mL), insufficient (20 to 29.9 ng/mL),

or having normal levels (>30 ng/mL). The incidence of vitamin D deficiency and insufficiency was compared to those with normal levels for statistical significance. Outcomes were further sub-stratified between men and women. All patients with less than normal levels were placed on daily vitamin D treatment.

All data were recorded using an excel spreadsheet (Microsoft Corporation, Redmond, WA). A student's t test was to calculate statistical differences of means. All statistical calculations were performed using GraphPad version 5.01 (GraphPad Software Inc., La Jolla, California). A p value of <0.05 was considered statistically significant.

Results

Incidence of Hip Fracture and Vitamin D Levels

There is an increased incidence of hip fracture in elderly patients 90 years old or higher with low levels of vitamin D. The overall cohort had mean vitamin D levels of 27.2 ng/ml (range, 4.3 to 69.4 ng/mL). Among the cohort, 64% of patients had significantly lower than normal Vitamin D levels ($p = 0.007$). This included 43% ($n = 20$) who were deficient and 21% ($n = 10$) who were considered insufficient according to the Endocrine Society guidelines. Only 36% ($n = 17$) of the cohort had normal vitamin D levels.

Incidence of Hip Fracture and Demographics

When outcomes were stratified by gender, men and women had similar mean vitamin D levels (29.4 versus 26.8 ng/mL; $p = 0.67$). However, females with hip fractures had much higher incidences of vitamin D deficiency and insufficiency compared to their male counterparts (Table 1).

Discussion

As the US elderly population continues to grow, the incidence of hip fractures is on the rise.¹ Several associations have been made in the literature between vitamin D levels and fracture risk,^{1,5-7} However, there is limited number of studies that explored the association between hip fractures and vitamin D levels in elderly patients above the age of 90. Our results show that a significant percentage of our patients aged 90 years or older, who presented with hip fractures to our institution, were either vitamin D deficient or insufficient. Women with hip fractures were more likely to have either deficient or insufficient vitamin D levels compared to their male counterparts. Adequate vitamin D levels has become increasingly emphasized in overall bone health in the elderly. Physicians and patients should be educated about the importance of vitamin D deficiency and its significant incidence in patients who present with a hip fracture.

This study has several limitations. This is a cross-sectional study that evaluated the incidence of vitamin D deficiency and insufficiency in those 90 years of age or older with hip fractures. Therefore, the temporal relationship between low vitamin D levels and hip fractures cannot be determined. Additionally, the sample size was relatively small which may have prevented us from achieving statistically significant result in males when compared to females regarding the association between hip fractures incidence and low vitamin D levels. Despite these limitations, the results of this study are important in understanding the relationship between vitamin D levels and hip fractures in those aged 90 years or older.

There are several studies that agree with our findings regarding vitamin D levels and fragility fractures. Bischoff-Ferrari et al. evaluated the association between vitamin D levels and hip fracture prevalence in 222 patients over a 12 month period with a mean age of 86 years.⁷ Up to 60% of hip fractures were associated with vitamin D levels of <30 ng/ml. Additionally, Johnson et al. conducted a retrospective comparative study comparing vitamin D levels between 448 patients who sustained hip fractures during 2010–2011 and 1091 patients who underwent elective total hip or knee surgery during the same period [8]. There was a significant number of patients who had vitamin D levels <29.9 in the hip fracture group compared to the control group (65.8% vs 54.0%, $P < 0.05$). Most recently, Lakkireddy et al. performed cross-sectional study of 100 patients with fragility hip fractures and their association with vitamin D deficiency and insufficiency.⁹ Ninety two patients in this cohort were either vitamin D deficient or insufficient with a mean vitamin D level of 16.1 ng/dL. Thus, there are multiple small and large studies that have shown an association with lower vitamin D levels and fragility hip fracture incidence.

Additionally, we found a greater association with insufficient or deficient vitamin D levels and sustaining a fragility hip fracture in women. Larrosa et al. conducted a cross-sectional study of 324 patients with a mean age of 83 years (80% women) who were admitted for osteoporotic hip fracture.¹⁰ Two hundred sixteen patients (67%) 55% women vs 12% men) had vitamin D levels <25 ng/ml. Although not fully understood, there may be a stronger correlation with lower vitamin D and an increased risk of hip fracture.

In conclusion, we found an association between the incidence of hip fractures and increased incidence of insufficient or deficient levels of vitamin D those over 90 years of age. As such, preventative measures are becoming increasingly important given its known morbidity and mortality. Future studies should examine how improvements in vitamin D levels can reduce potential risk of fragility hip fractures in patients aged 90 years or older and how might that affect the recovery time.

References

- 1 Tsuda T. Epidemiology of fragility fractures and fall prevention in the elderly: a systematic review of the literature. *Curr Orthop Pract*. 2017;28(6):580.

Table 1 | Gender and Vitamin D levels

Gender	< 30 ng/mL (%)	> 30 ng/mL (%)	p-value
Men	43%	57%	0.6
Women	68%	33%	0.002

- 2 Wang XF, Seeman E. Epidemiology and structural basis of racial differences in fragility fractures in Chinese and Caucasians. *Osteoporos Int.* 2012;23(2):411.
- 3 Yu F, Xia W. The epidemiology of osteoporosis, associated fragility fractures, and management gap in China. *Arch Osteoporos.* 2019; 14(1):32.
- 4 Cenzer IS, Tang V, Boscardin WJ, Smith AK, Ritchie C, Wallhagen MI, Espaldon R, Covinsky KE. One-Year Mortality After Hip Fracture: Development and Validation of a Prognostic Index. *J Am Geriatr Soc.* 2016;64(9):1863.
- 5 Friedman SM, Mendelson DA. Epidemiology of fragility fractures. *Clin Geriatr Med.* 2014;30(2):175.
- 6 Cooper C. The epidemiology of fragility fractures: is there a role for bone quality? *Calcif Tissue Int.* 1993;53(Suppl 1):S23.
- 7 Bischoff-Ferrari HA, Can U, Staehelin HB, Platz A, Henschkowski J, Michel BA, Dawson-Hughes B, Theiler R. Severe vitamin D deficiency in Swiss hip fracture patients. *Bone.* 2008;42(3):597.
- 8 Johnson AL, Smith JJ, Smith JM, Sanzone AG. Vitamin D insufficiency in patients with acute hip fractures of all ages and both sexes in a sunny climate. *J Orthop Trauma.* 2013;27(12):e275.
- 9 Lakkireddy M, Mudavath SV, Karra ML, Arora AJ. Hypovitaminosis D in patients with osteoporotic hip fractures. *J Clin Orthop Trauma.* 2019;10(4):768.
- 10 Larrosa M, Gomez A, Casado E, Moreno M, Vazquez I, Orellana C, Berlanga E, Ramon J, Gratacos J. Hypovitaminosis D as a risk factor of hip fracture severity. *Osteoporos Int.* 2012;23(2): 607.