TPM Vol. 32, No. S2, 2025
ISSN: 1972-6325
https://www.tpmap.org/

Open Access

ASSOCIATION OF BIOCHEMICAL MARKERS WITH SEVERITY OF HIP FRAGILITY FRACTURES

DR. NAVEEN KARTHIK. M.S(ORTHO)
DEPARTMENT OF ORTHOPAEDICS, SAVEETHA MEDICAL COLLEGE AND HOSPITAL, SAVEETHA INSTITUTE OF MEDICAL AND TECHNICAL SCIENCES, CHENNAI, INDIA

DR. ARUN KUMAR C
DEPARTMENT OF ORTHOPAEDICS, SAVEETHA MEDICAL COLLEGE AND HOSPITAL, SAVEETHA INSTITUTE OF MEDICAL AND TECHNICAL SCIENCES, CHENNAI, INDIA

Abstract

Background:

In elderly individuals, fragility fractures occur due to significantly reduced bone strength caused by changes in bone mass, architecture, and material properties. These fractures typically result from low-energy injuries and are associated with vitamin D insufficiency as an independent risk factor. Vitamin D deficiency is also linked to poor muscle function, muscle weakness, increased fall risk, inadequate post-injury rehabilitation, and a higher likelihood of refracture. Understanding the relationship between vitamin D, serum calcium, and hip fracture severity can aid in developing personalized prevention strategies, improving prognosis, optimizing treatment plans, and delivering tailored therapeutic approaches.There have been no studies to see for an association of serum calcium and vitamin D with the severity of fragility hip fractures. Our study aims to analyze the baseline differences of calcium and vitamin D levels in patients with different types of hip fractures and their severity. Objectives: a) To determine the serum calcium levels and serum Vitamin-D levels in elderly patients having fragility hip fractures at Saveetha Medical College , Thandalam, Chennai,TamilNadu, India . b) To categorize hip fractures based on their type and further subclassify them based on their severity. c) To correlate the calcium and Vitamin-D and levels in elderly patients with severity of fractures of hip which are further classified based on age and gender.

Materials and Methods: A hospital-based descriptive prospective study was conducted among elderly patients (over 50 years of age) who presented with fragility fractures of the hip joint at the Emergency Trauma Care Center and OPD of the Orthopaedic Department at Saveetha Medical College , Thandalam, Chennai,TamilNadu, India. The study period was from october1, 2022, to october1, 2023. A total of 30 patients were included in the study. The patient's biographical information, injury date, and fracture type were recorded. The levels of serum calcium and vitamin D were measured and reported upon admission. Data Management: Version 23 of the Statistical Package for the Social Sciences (SPSS) was used to input, code, and analyze the data. The main findings were the levels of calcium and 25-hydroxycholecalciferol in the serum. The distribution of 25-hydroxycholecalciferol and calcium was summarized using means with standard deviations and the median with interquartile range (IQR). The Kruskal-Wallis and Mann-Whitney tests were conducted to determine if serum calcium and vitamin D levels correlated with specific patient features. The association between serum calcium and vitamin D levels and gender groups, different types of fractures, and the severity of fractures was examined using the chi-square test. Results: Out of 30 enrolled patients for the study, 37.5% were of the age group 60-69 years, with a male predominance of 63.3%. More men had deficient vitamin D levels than women.

Keywords: Neck of femur fracture, Intertrochanteric femur fracture, Sub trochanteric femur fracture.

Result: 53.3% of the participants in the research showed vitamin D insufficiency. Only 6% of people had normal blood vitamin D levels, while 6% were vitamin D deficient. For 13.3% of the research subjects, the albumin-adjusted calcium levels were normal, but for 11% of them, calcium levels were low. The most common type of hip fracture was neck of femur fracture at 43.3%, followed by Intertrochanteric fracture at 50%, and subtrochanteric femur fracture at 6.66%. Among Intertrochanteric femur fractures, 6.6% belonged to Boyd and Griffin type 4 and 10% belonged to type 1. Among neck of femur fractures, 10% belonged to Garden's type 4 and 23.3% belonged to

type 1. Among subtrochanteric femur fractures, 6.6% belonged to Russell-Taylor's type 1 . Thus, the maximum percentage of patients with different hip fractures presented to us belonged to the more severe type of their respective fractures. There was a statistically significant difference seen for the intertrochanteric femur fracture, neck of femur fracture, and subtrochanteric femur fracture for the varying levels of serum calcium and vitamin D. 38.4% of intertrochanteric femur fracture and 33.3% of neck of femur fracture patients had hypocalcemia. 23% of intertrochanteric femur fracture and 20% of neck of femur fracture had vitamin D deficiency. There was a significant association of serum calcium and vitamin D levels with the severity of hip fractures. Among intertrochanteric femur fractures, all type 4 fractures had hypocalcemia (100%) and vitamin D insufficiency (100%). Among neck of femur fractures, almost all type 4 fractures had hypocalcemia (100%) and vitamin D deficiency (100%).

Conclusion: We concluded that the prevalence of vitamin D deficiency and insufficiency, as well as hypocalcemia, was high in this study. This was especially true when evaluated among different types of hip fractures and their severity. We could conclude that the more deficient the serum calcium levels and the more deficient/insufficient the serum vitamin D levels, the more severe the type of fracture. A weak statistically significant association was found between serum calcium and vitamin D levels with age and sex.

Keywords: Bone Mineral Density , intertrochanteric, hypocalcemia, neck of femur, Boyd and Griffin,Russell-Taylor's, gardens Classification

INTRODUCTION

Fragility fractures are those that occur without significant trauma or due to minimal trauma, such as a fall from standing height. The risk of experiencing a fragility fracture increases with age. Bone fragility refers to the susceptibility of bone to fracture, and from a biomechanical perspective, it is defined by three key factors: strength, brittleness, and work to failure. [1] A decrease in periosteal bone formation, continuous bone resorption within the basic multicellular unit (BMU) leading to remodeling on the bone's endosteal surface, and an increased rate of remodeling are the primary factors that impact the cellular mechanisms responsible for attaining peak bone strength.[2] Fragility fractures of the hip are a major concern worldwide due to their strong association with increased morbidity and mortality. They are the most frequently operated fractures of the proximal femur, largely because the cost of post-injury care for untreated patients is high. Among surgically managed fragility fractures, they carry the highest postoperative mortality rate and represent a significant burden on healthcare resources. Approximately one-third of elderly patients with hip fractures die within the first year of injury, and many fail to regain their pre-fracture functional status. [3] Research indicates that the prevalence of vitamin D deficiency in patients with hip fractures ranges from 55% to 92%, with rates being higher among elderly individuals in Western countries, often showing seasonal variation. Older adults are at greater risk due to factors such as inadequate sun exposure, reduced skin synthesis of vitamin D, dietary insufficiency, impaired intestinal absorption, and decreased hydroxylation and absorption in the liver and kidneys. Vitamin D deficiency is associated with increased muscle weakness and pain, which in turn reduces muscle strength, balance, and overall function. It also accelerates bone turnover and raises the risk of falls, leading to hip fractures in the elderly. Some authors have reported that vitamin D–deficient hip fracture patients experience slower fracture healing and higher mortality rates. [4- 6] Serum calcium and vitamin D levels in patients with hip fragility fractures have not been previously studied in the local population. The results of this study aim to assist orthopedic surgeons in managing such patients by considering their serum vitamin D and calcium levels.

Case definition for fragility fractures of the hip:

A fragility fracture is a pathological fracture resulting from minimal trauma (such as a fall from standing height) or from no identifiable trauma at all. It serves as both a sign and a symptom of osteoporosis.

Type of hip fracture:

- Fracture of the neck of the femur
- Intertrochanteric femur fracture
- Subtrochanteric femur fracture

Subclassifications (severity):

- Neck of the femur fracture: Garden classification (types 1, 2, 3, 4)
- Intertrochanteric femur fracture: Boyd and Griffin classification (types 1, 2, 3, 4) • Subtrochanteric femur fracture: RussellTaylor's classification (types 1, 2)

It is important to note that measuring serum vitamin D and serum calcium levels cannot be used as a screening tool for diagnosing osteomalacia. The gold standard for diagnosing osteomalacia and osteoporosis remains bone

histopathology. In this study, we employed a simple yet novel approach to correlate biochemical markers with the severity of hip fragility fractures.

Sr.Vit D levels	
Vit d deficiency	<21ng/ml
Vit d insufficiency	21-29ng/ml
Vit d sufficiency	>30ng/ml
Sr.calcium levels	
Sr.calcium deficiency	<8.5ng/ml
Sr.calcium insufficiency	8.5-10.2ng/ml
Sr.calcium sufficiency	>10.2ng/ml

MATERIALS AND METHODS:

A hospital-based descriptive prospective study was conducted among elderly patients (over 50 years of age) who presented with fragility fractures of the hip joint at the Emergency and OPD of the Orthopaedic Department at SMC (saveetha medical college and research institute) Thandalam , Chennai . The study period was from June 1, 2023, to December 1, 2023. A total of 30 patients were included in the study. The patient's biographical information, mode of injury, fracture type were recorded. The levels of serum calcium and vitamin D , BMD using DEXAscan were taken measured and reported upon admission .Ethical approval was obtained from the committee responsible for overseeing systematic review of these patients.Inclusion criteria included (1) patients >50 years of age, (2)patients with hip fragility fractures, (3) patients willing for investigations. All routine blood investigations was done to rule out other metabolic conditions that could significantly affect the outcomes, and any such patients were excluded from the study. Exclusion criteria included (1) patients not giving consent to study (2) patients less than 50 years of age , (3) patients with a history of previous use of antiresorptive drugs or long term steroid intake, (4) patients with severe comorbidities with poor life expectancy, (5) patients with other associated metabolic disorders, (6) patients with DEXA score of > -2.5 at presentation, and (7) patients with multiple fractures,(8)patients with pathological and open fractures

In adherence to strict ethical guidelines, written informed consent was obtained from all patients. A detailed medical history was recorded, followed by general physical and systemic examinations, after which relevant investigations were carried out. Patients with a low BMI (<18.5) were classified as underweight and excluded from the study, as their nutritional status and dietary habits were deemed potentially unreliable and could have influenced the outcomes.. Patients included in the study were informed about the surgical procedure, postoperative medications, and rehabilitation programs, and their consent to participate was obtained before proceeding with surgery. Modern hip arthroplasty techniques—such as proximal femoral nailing, cemented or uncemented bipolar hemiarthroplasty, and total hip replacement—were used for elderly patients with femoral neck fractures, based on fracture classification. Intertrochanteric fractures were treated using standard methods like dynamic hip screw fixation and intramedullary nailing, following the same principles. All patients received postoperative care, were mobilized early, and underwent regular follow-up.

Data Management:

Version 23 of the Statistical Package for the
Social Sciences (SPSS) was used to input, code, and analyze the data. The main findings were the levels of calcium and 25-hydroxycholecalciferol in the serum and BMD using DEXAscan measured . The association between serum calcium and vitamin D levels and gender groups, different types of fractures with their BMD was taken into account and the correlation was examined using the chi-square test and $p<0.05$ was considered significant.

Table 1: Correlation of Serum Calcium and Serum Vitamin-D with types of hip fractures and their severity (subtypes)

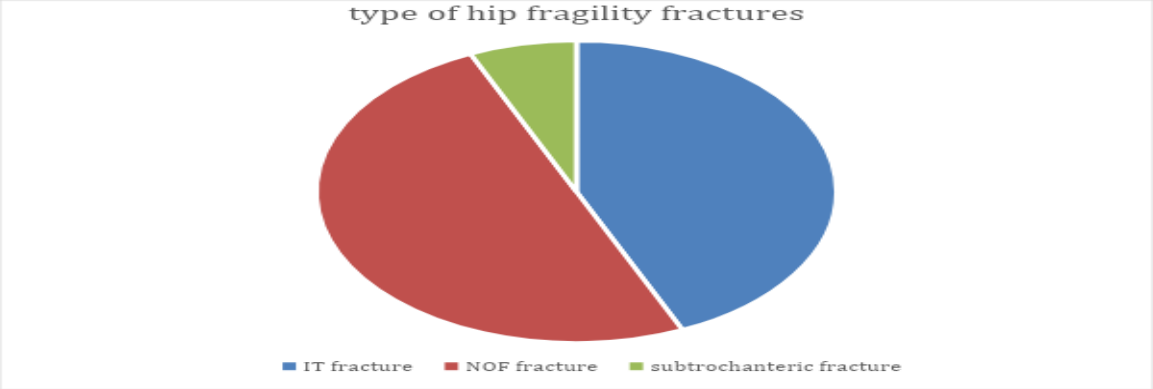
HIP FRACTURES	Number of patients	Mean Serum Calcium levels(mg/dl)	Mean serum VitaminD levels(ng/dl)	P Value
Intertrochanteric Femur Fracture (Boyd and Griffin)	13(43.33%)	8.4	26	0.001
Type-1	3(10%)	9.8	29.8	
Type-2	5(33)	8.7	27.1	
Type-3	3(10%)	8.2	26.7	

Type-4	2(6.66%)	6.9	20.4	
Neck of femur fracture (Gardens) Type-1 Type-2 Type-3 Type-4	15(50%) 7 (23.3%) 3(10%) 0 3(10%)	8.4 9.7 8.5 0 7.2	24.6 28.3 24.7 0 20.8	0.001
Subtrochanteric femur fracture (Russell and Taylor's) Type-1 Type-2	2(6.66%) 2(6.66%) 0	7.9 7.9	23.2 23.2	0.001

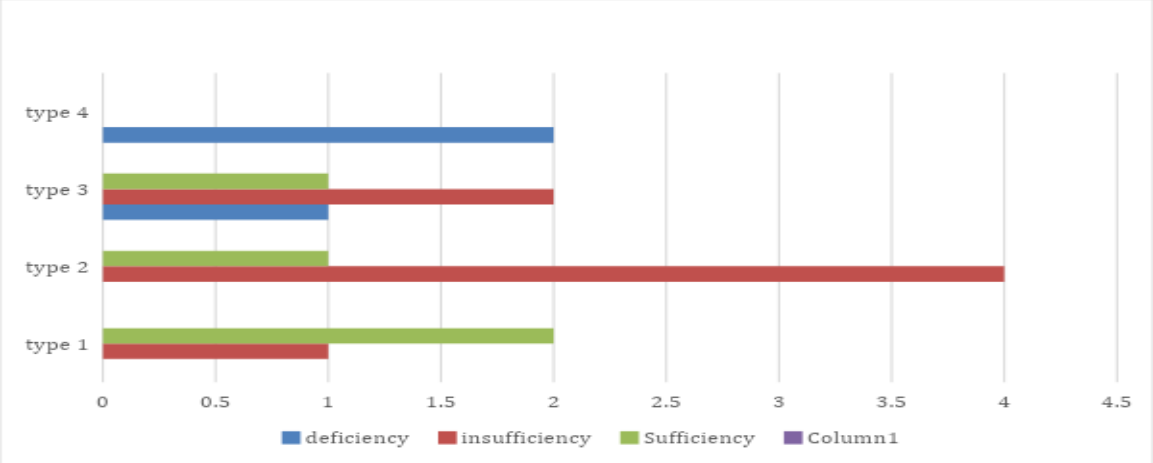
Table 2: Association of Serum Calcium and Serum Vitamin-D levels with types of hip fractures and their severity (subtypes)

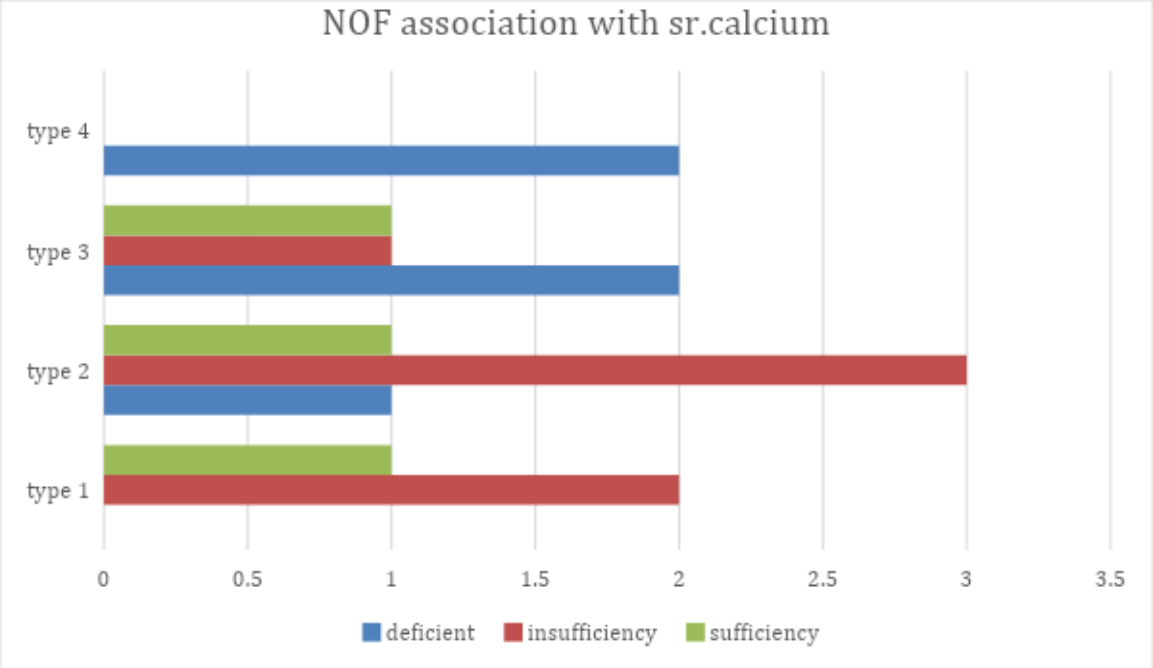
Diagnosis	Serum Calcium (mg/dl) < 8.5	Serum Calcium (mg/dl) 8.5-10.2	Serum Calcium (mg/dl) 10.3+	Serum Vitamin-D(ng/dl) <= 20	Serum Vitamin-D(ng/dl) 21 – 29	Serum Vitamin-D(ng/dl) 30 +	Total	P value
Inter trochanteric femur fracture (Boyd and Griffin) Type-1 Type-2 Type-3 Type-4	**5(16.6)** **0** **1(3.3%** **2(6.6%** **2(6.6%**	**6(20%)** **2(6.6%** **3(10%)** **1(3.3%** **0**	**2(6.6%)** **1(3.3%** **1(3.3%** **0** **0**	**3(10%)** **0** **0** **1(3.3%** **2(6.6%**	**7(23.3%** **)** **1(3.3%** **4(13.3)** **2(6.6%** **0**	**3(10%)** **2(6.6%** **1(3.3%** **0** **0**	**13(43.3%)**	0.0001
Neck of femur fracture (Gardens) Type-1 Type-2 Type-3 Type-4	**5(16.6)** **1(3.3%** **1(3.3%** **0** **3(10%)**	**7(23.3%** **)** **5(16.6** **2(6.6%** **0** **0**	**1(3.3%** **1(3.3%** **0** **0** **0**	**3(10%)** **0** **0** **0** **3(10%)**	**7(23.3%** **)** **4(13.3)** **3(10%)** **0** **0**	**3(10%)** **3(10%)** **0** **0** **0**	**15(50%)**	0.0001
Subtrochanteric femur fracture (Russell and Taylor's) Type-1 Type-2	**2** **2**(6.6%) **0**	**0** **0** **0**	**0** **0** **0**	**0** **0** **0**	**2** **2**(6.6%) **0**	**0** **0** **0**	**2(6.6%)**	0.0001
Total	**11(36.7%)**	**13(43.3%)**	**4(13.3%)**	**6(20%)**	**16(53.3%)**	**6(20%)**	**30**	

Figure 1



It FRACTURE ASSOCIATION WITH NO OF PTS WITHSR.VIT D DEFICIENCY





DISCUSSION

Osteoporosis is characterized by a loss of bone mass and deterioration of bone structure, making bones fragile and susceptible to fractures. In affected individuals, these fragility fractures cause significant pain, disability, and even mortality. Most fragility hip fractures occur indoors, with a similar distribution between genders. Aging,

osteoporosis, and diabetes are key predictors of poor outcomes. This study emphasizes the need for new strategies, combining various factors to identify and correlate predictors of fragility fractures.

A total of 30 patients were enrolled in the study after meeting the inclusion criteria. Of these, 11 (36.67%) were female and 19 (63.33%) were male. The age distribution of patients with hip fractures was as 11 (36.67%) were aged 60-69 years, 7 (21.%) were aged over 80 years.

Of the 30 patients, 13 had an intertrochanteric femur fracture, 15 had a neck of femur fracture, and 2 had a subtrochanteric femur fracture.

Serum calcium levels were evaluated among the hip fractures. The mean calcium level in intertrochanteric femur fractures was 8.83 mg/dl (n=71) with a standard deviation of 0.956. The mean calcium level in neck of femur fractures was 8.71 mg/dl (n=35) with a standard deviation of 0.926. The mean calcium level in subtrochanteric femur fractures was 10.14 mg/dl (n=14) with a standard deviation of 0.949.

Serum vitamin D levels were also evaluated among the hip fractures. The mean vitamin D level in intertrochanteric femur fractures was 21.85 ng/dl (n=71) with a standard deviation of 4.662. The mean vitamin D level in neck of femur fractures was 21.03 ng/dI (n=35) with a standard deviation of 4.402. The mean vitamin D level in sub-trochanteric femur fractures was 28.00 ng/dl (n=14) with a standard deviation of 3.595,.

In a 2012 study by Larrosa M et al., it was concluded that while individuals with intracapsular and extracapsular hip fractures have similar blood vitamin D levels, there is a stronger association between severe osteoporotic hip fractures and profound vitamin D deficiency—the greater the deficit, the stronger the correlation. Prior vitamin D supplementation may help prevent these fractures from progressing to more severe forms..[6] In a 2020 study by Hwang et al., it was concluded that in elderly individuals, unstable intertrochanteric fractures are associated with low calcium and vitamin D levels. Maintaining adequate levels of these nutrients may help prevent an increase in the severity of intertrochanteric fractures..[7] In a 2019 study by Maheshwar Lakkireddy et al., it was concluded that there is a significant association between hypovitaminosis D, osteoporosis, and fracture site comminution. The presence of fracture site comminution and the high prevalence of vitamin D deficiency in patients with hip fractures highlight the need for effective supplementation and thorough assessment of vitamin D levels in elderly individuals, along with anti-osteoporotic treatments, to ensure proper management and effective prevention of osteoporotic hip fractures..[8]

According to Atsuko Kanno et al., patients with trochanteric fractures had significantly lower vitamin D levels and significantly higher PTH levels compared to those with neck fractures.Low serum calcium levels are directly associated with a higher risk of developing fragility hip fractures in the elderly. According to Gadde Saikrishna et al., serum calcium may serve as a sensitive predictor for the likelihood of such fractures.The study examined the relationship between serum calcium, serum vitamin D, and serum PTH levels with different types of hip fragility fractures. Results showed a statistically significant association ($p = 0.0001$), indicating that more severe hip fracture types were linked to lower serum calcium and vitamin D levels, along with higher PTH levels.

Ask ChatGPT

CONCLUSION

We conclude that vitamin D deficiency, insufficiency, and hypocalcemia were highly prevalent in this study, particularly when analyzed across different types and severities of hip fractures. The findings suggest that lower serum calcium and reduced or insufficient vitamin D levels are associated with more severe fracture types (Table 2). A weak but statistically significant correlation was also observed between serum calcium and vitamin D levels and the patients' age and gender.

Declaration:
Funding: none
Conflict of interest: none declared
Ethical approval : approval taken from the ethical committee

RESULT:

Between October 2022 and October 2023, 30 patients with hip fragility fractures were evaluated preoperatively and underwent surgical intervention. The study included 19 males and 11 females, with ages ranging from 61 to 89 years, and a mean age of 70 years.

The average time from injury to hospital admission was 3 days, with a range of 1 to 5 days. Before treatment, patients' serum PTH, vitamin D, and calcium levels were measured. The mean serum calcium level was 8.6 mg/dL, ranging from 7 to 10.2 mg/dL. Lower serum calcium and vitamin D levels were associated with earlier fracture occurrence, indicating a linear relationship between these parameters and the incidence of hip fragility fractures, as presented in Table 2. Statistical analysis revealed a significant correlation between the two variables ($p = 0.0001$), confirming that lower serum calcium and vitamin D levels are linked to greater severity of hip fragility fractures.

REFERENCE

1. Turner CH. Biomechanics of Bone: Determinants of Skeletal Fragility and Bone Quality.Osteoporos Int. 2002 Feb 1; 13(2):97– 104.
2. Adler R. Osteoporosis: Pathophysiology and Clinical Management, Humana Press; 20 8: 183-89.
3. Marks R. Hip fracture epidemiological trends, outcomes, and risk factors, 1970–2009. Int J Gen Med. 2010 Apr 8; 3:1–17.
4. Cauley JA, Lacroix AZ, Wu L, Horwitz M, Danielson ME, Bauer DC, et al. Serum 25- hydroxyVitamin-D concentrations and risk for hip fractures. Ann Intern Med. 2008 Aug 19; 149(4):242–50.
5. Halfon M, Phan O, Teta D. Vitamin-D: A Review on Its Effects on Muscle Strength, the Risk of fall, and Frailty. BioMed Research International. 2015 6. Jones G, Strugnell SA, DeLUCA HF. Current Understanding of the Molecular Actions of Vitamin-D. Physiol Rev. 1998 Oct 1; 78(4):1193–231.
6. Larrosa M, Gomez A, Casado E, Moreno M, Vázquez I, Orellana C, Berlanga E, Ramon J, Gratacos J. Hypovitaminosis D as a risk factor of hip fracture severity. Osteoporos Int. (2012) Feb;23(2):607-14. doi: 10.1007/s00198-011-1588-z. Epub 2011 Mar 11. PMID: 21394494
7. Hwang, Seok-Min & Hwang, Suk-Hyun & Kim, Yeon-Ho. (, 2020). Association of Serum Vitamin-D and Calcium Levels With the Severity of Intertrochanteric Fractures in the Elderly: A Retrospective Study. 10.21203/rs.3.rs-34943/v1.
8. Lakkireddy, M.Vardhan Mudavath, S., Karra, M. L., & Arora, A. J. (2019). Hypovitaminosis D in patients with osteoporotic fractures of the hip. Journal of clinical orthopaedics and trauma, 10(4), 768-773.