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Original article

Prevalence of vitamin D deficiency in orthopaedic patients – A single centre study

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ABSTRACT

Purpose: Many recent reports demonstrated high rates of vitamin D deficiency in numerous segments of Indian population but no study has been reported so far from India, which focuses specifically on vitamin D status in orthopaedic patients. This study finds out the prevalence of vitamin D deficiency in orthopaedic patients in India.

Methods: Vitamin D levels of 1132 patients were measured from OPD and Emergency Department of S.N. Medical College, Agra from 1 November 2011 to 31 October 2013. Serum 25(OH) vitamin D, calcium, phosphorus, alkaline phosphatase and routine blood investigations were done. BMI and daily sun exposure were measured.

Results: Out of 1132 patients included in our study, 732 (64.7%) were males and 400 (36.3%) females. Vitamin D deficiency (<30 ng/ml) was present in 1034 patients (91.3%); among them, 693 patients (61.2%) had vitamin D level <20 ng/ml and only 98 patients (8.7%) had sufficient levels of vitamin D. Vitamin D deficiency was more in elderly patients (61–80) than in younger patients. Among 1132 patients, 670 males (91.5%) and 364 females (91.0%) were found to have serum 25(OH) vitamin D levels <30 ng/dl cut-off for vitamin D sufficiency (p-value = 0.75). Vitamin D levels were lower in patients with less mean sun exposure time. BMI level was more in deficient group than the sufficient group relatively.

Conclusion: High incidence of vitamin D insufficiency and deficiency likely exists across all age groups among orthopaedic patients. Screening and treating hypovitaminosis D appears to be important in this patient population.

1. Introduction

Vitamin D has been traditionally known as the anti-ricketic factor or the sunshine vitamin. It plays a crucial role in calcium homeostasis and appropriate serum calcium concentrations are essential for many functions, including proper mineralization of the bone, muscle contraction and transmission of nerve impulses.[1] Chronic vitamin D deficiency leads to osteoporosis, osteomalacia, muscle weakness, osteoarthritis, nonspecific backache, gout, ankylosing spondylitis, generalized body ache, increased risk of falls, etc.[2]

Vitamin D deficiency does indeed constitute an epidemic in many populations across the world and has been reported in healthy population across all age groups and both genders.[3] In India also, more than 90% of apparently healthy Indians have subnormal 25(OH)D levels.[4] Reports documenting incidences of vitamin D deficiency in the orthopaedic patients as compared to apparently healthy population are sparse in literature. Data revealing the prevalence of vitamin D sufficiency and insufficiency may be of value to orthopaedic surgeon when treating their patients to prevent potential negative consequences in the operative and postoperative settings, to maintain good physical function and to preserve independence in daily life.

The purpose of this observational study was to evaluate serum levels of vitamin D in patients presenting with orthopaedic illness in Orthopaedic Department at Sarojini Naidu Medical College and Hospitals, Agra in Uttar Pradesh.

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2. Material and methods

This study was conducted on patients attending the Orthopaedic OPD and Emergency Department of Sarojini Naidu Medical College, Agra. A total of 1132 patients from both sex between 20 and 80 years were included in this study. All participants were recruited after taking written informed voluntary consent. The study subjects were recruited after a careful history, general and systemic physical examination. The questionnaire recorded information on age, co-morbidity status (such as diabetes mellitus, hypertension and ischaemic heart disease) and medication use including oral vitamin D supplementation. Height and weight were measured, and the body mass index (BMI) was calculated. BMI was defined as the weight in kilograms divided by the square of the height in metres. Direct sunlight exposure was assessed by documenting average duration of exposure and percentage of the surface area of the body exposed daily. The average duration of cloud-free sunshine during the years of study (2012–2014) was 7.4 h/day in winter months (October to March) and 9.5 h/day in summer (April to September), according to the data provided by the Meteorology Department of U.P. Orthopaedic patients from both sex from age group 20 years to 80 years coming to Orthopaedic OPD and Emergency Department were included in the study.

2.1. Exclusion criteria

Subjects with age <20 years and >80 years, pregnant and lactating women, person residing in U.P. less than last 5 years at the time of their recruitment into the study, person taking drugs that can affect bone mineral metabolism, patient with history of surgery, hospitalization or major medical illness within the past one year, diabetes mellitus patient, cancer patient, patient with hepatic, renal and dermatological disorders, alcoholic persons, person taking vitamins and mineral supplementation since last 6 months and using sunscreen creams were excluded.

From each study subject, 10 ml blood sample was drawn after an overnight fast without venostasis. The samples were placed in ice boxes. Whole blood was transported under chilled condition to the lab in batches. In lab, serum was separated after centrifugation at 3000 rpm for 15 min at 4 °C. After centrifugation, the serum was stored in the laboratory freezer at minus 20 °C, until further analysis. Serum 25(OH)D concentrations will be estimated by using a radioimmunoassay. Serum marker measured included total calcium (Ca), inorganic phosphate, intact parathyroid hormone (PTH-i), alkaline phosphates and 1,25(OH)2D. The venous blood samples for PTH analysis were collected in EDTA plasma collection tubes. Intact PTH was determined by a two site binding immunoradiometric assay. Direct sunlight exposure was assessed by documenting average duration of exposure and percentage of the surface area of the body exposed daily. The subjects were classified as vitamin D deficient, insufficient or sufficient on the basis of 25(OH)D concentrations of <20 ng/ml, 21–29 ng/ml and 30–100 ng/ml respectively, according to recent consensus.[5]

2.2. Statistical analysis

The data was categorized in *n* (%). The chi-square test was used to compare differences in the various indices. A *p*-value of <0.05 was taken to be statistically significant.

Table 1
Vitamin D status in all patients (*n* = 1132).

Total patients	*n* = 1132
Frank deficiency (<20 ng/ml)	693 (61.2%)
Insufficiency (21–29 ng/ml)	341 (30.1%)
Sufficient (>30 ng/ml)	98 (8.7%)

3. Results

Our sample of 1132 patients comprised of 732 (64.7%) males and 400 (35.3%) females. The mean age of the sample was 42 years. The minimum age in the sample was 20 years and the maximum age was of 80 years. Majority of the patients belonged to Agra, Firozabad, Manipuri, Aligarh, Etah, Etawah, Hathras, Mathura and Kasganj district.

Vitamin D deficiency (<30 ng/ml) was present in 1034 patients (91.3%); among them, 693 patients (61.2%) had vitamin D level <20 ng/ml and only 98 patients (8.7%) had sufficient levels of vitamin D (Table 1).

According to age groups, vitamin D deficiency was more in elderly patients (61–80) than in younger patients. Vitamin D sufficiency in patients of 61–80 year age group was 4.7% and in patients of age group 41–60 years and 20–40 years was 10.2% and 9.7% (Table 2). This difference in vitamin D sufficiency was statistically significant between 61–80 years and 41–60 years (*p*-value <0.0001 and chi-square test = 21.146) and between 61–80 years and 21–40 years (*p*-value <0.0001 and chi-square test = 17.96).

Among 1132 patients, 670 males (91.5%) and 364 females (91.0%) were found to have serum 25(OH) vitamin D levels <30 ng/dl cut-off for vitamin D sufficiency. Vitamin D deficiency (<20 ng/dl) was more frequently observed in females (62.5%) than in males (60.5%); however, this difference was not statistically significant (*p*-value = 0.75). Looking at continuous relationships, vitamin D levels in the sample were significantly different between males and females. In age group of 41–60 years group, vitamin D insufficiency (20–30 ng/dl) was 28.6% and 34.1% respectively in males and females that was significantly different (chi-square test = 6.775; *p*-value = 0.0092), vitamin D deficiency (<20 ng/dl) in same group between males and females was also significantly different (chi-square test = 14.82; *p*-value = 0.0001) and vitamin D sufficiency was also significant in this age group (chi-square test = 5.381; *p*-value = 0.0204). Vitamin D deficiency in 61–80 years group was also significant between males and females (chi-square test = 43.668; *p*-value <0.0001), vitamin D insufficiency was also significantly different in this age group between males and females (chi-square test = 47.22; *p*-value <0.0001). Vitamin D deficiency between patient coming to OPD and Emergency Department was 89.8% and 92.6% respectively. Patients from OPD Department had more sufficient level of vitamin D (10.5%) than patients coming to Emergency Department (7.4%). This association was considered to be statistically significant (chi square test = 5.22; *p*-value = 0.0188) (Table 2). Daily sunlight exposure greater than 30 min had vitamin D sufficiency in 16.3% patients that is better than overall vitamin D sufficiency 8.7%. These data were not found to have a significant association with vitamin D levels, as depicted by *p*-values of 0.092. BMI level was

Table 2
Age-wise distribution of vitamin D deficiency.

Age groups	Vitamin D deficiency	Vitamin D insufficiency	Vitamin D sufficiency
20–40 years	287 (59.1%)	152 (31.3%)	47 (9.7%)
41–60 years	219 (59.0%)	114 (30.7%)	38 (10.2%)
61–80 years	187 (69.0%)	75 (27.3%)	13 (4.7%)

Table 3
Patients sample characteristic with respect to vitamin D groups (median values and inter-quartile range are reported.).

Subjects characteristics	Deficiency (n = 693)	Insufficiency (n = 341)	Sufficiency (n = 98)	p-Value
Median vitamin D levels (ng/ml)	14.5 (8.9–16.9)	24.8 (22.2–26.8)	33.1 (31.9–37.0)	0.001
BMI (kg/m^2)	28.6 (25.2–30.8)	26.3 (24.6–30.2)	25.9 (23.8–28.7)	0.321
PTH (pg/ml)	43.7 (34.9–56.7)	35.5 (26.8–43.7)	38.6 (27.9–48.7)	0.001
Calcium (mg/dl)	9.46 (9.24–9.67)	9.44 (8.92–9.68)	9.49 (9.23–9.71)	0.189
Phosphorus (mg/dl)	3.14 (2.71–3.43)	3.08 (2.88–3.45)	3.18 (2.78–3.61)	0.846
Alkaline phosphate (U/L)	91 (79–106)	95 (74–108)	97 (72–116)	0.819
Daily sunlight >30 min (n = 239)	143 (59.8%)	57 (23.8%)	39 (16.3%)	0.092

more in deficient group than the sufficient group relatively but no significant correlation was found (p-value = 0.321) (Table 3).

4. Discussion

Vitamin D deficiency is endemic in India. Numerous reports have highlighted the low levels of vitamin D noted in various spectrum of the population, including young adults, hospital personnel, postmenopausal women, school children.[2,6,7] All the prospective studies, however, have analyzed healthy subjects. No prospective or cross-sectional study has been reported so far from India, which focuses specifically on vitamin D status in Orthopaedic OPD and Emergency Department patients. This is, to the best of our knowledge, the first such study with regard to prevalence of vitamin D in Orthopaedic OPD and Emergency Department patients in India.

We estimated a high prevalence of vitamin D deficiency in this cohort of orthopaedic patient of Western U.P. We found that vitamin D deficiency (<30 ng/dl) was present in 91.3% patients, among which 61.2% patients had vitamin D level <20 ng/dl and only 8.7% patients had sufficient levels of vitamin D. A similar study in orthopaedic trauma patients with hip fracture in Indian patients found very high prevalence (96.7%) of vitamin D deficiency conducted in AIIMS, New Delhi.[8] Kalra et al. found 94.03% prevalence of vitamin D deficiency in OPD female patients with musculoskeletal symptoms conducted in Haryana.[9] These results are consistent with those of similar studies investigating the prevalence of vitamin D deficiency in orthopaedic surgery patients in USA, Germany and Australia.[10–13] Plotnikoff et al. found that 93% patients had vitamin D deficiency in a study group of 150 outpatients with persistent, nonspecific, musculoskeletal pain syndromes refractory to standard therapy in Minneapolis.[14] A similar study conducted by Simonelli et al. among a population of 82 adult patients with minimal trauma fractures found that 97.4% patients had vitamin D level <30 ng/dl and majority (81%) of patients had 25(OH)D <20 ng/ml.[15] Ryan and Dixon found that 88.7% patients had a vitamin D level <80 nmol/L among 870 OPD patients and in patients with fragility fractures in Medway, Europe.[16] Zellner et al. reported prevalence of vitamin D deficiency (<20 ng/ml) in 53.2% patients and vitamin D insufficiency (<30 ng/ml) in 86.2% patients among 652 trauma patients admitted to Orthopaedic Surgery Department in Houston, TX.[17] Vitamin D status of 60 elderly hospitalized subjects in Iceland found that 84.2% patients suffered from vitamin D deficiency (<30 ng/ml).[18] A similar prevalence was found in Karachi in OPD patients where hypovitaminosis D was present in 92% patients.[19] In our study, we found that patients more than 60 years of age had more vitamin D deficiency as compared to younger age group. Similar study shows that older adults are often considered at increased risk of vitamin D deficiency due to limited sun exposure, decreased capacity for cutaneous vitamin D synthesis[20,21] and reduced intake of dietary vitamin D.[22] Some clinical studies also demonstrated that age is not a good predictor of 25(OH)D concentrations. Some studies of orthopaedic surgery patients found high-prevalence rates of hypovitaminosis D among younger adult patients.[10,23] One of these studies found that patients of 51–70 years of age were 35% less at risk for hypovitaminosis D compared with those of 18–50 years of age.[10] Studies focusing on young adults, teens and children also found prevalence rates of 42–90%.[24] Therefore, considering published clinical data, we conclude that although the elderly are at risk for hypovitaminosis D, the risk extends to individuals of all ages, and that age is not a good predictor of serum 25(OH)D status. According to sex, we found that vitamin D deficiency (<20 ng/dl) was more frequently observed in females (62.5%) than in males (60.5%); however, this difference was not statistically significant (p-value = 0.75). The female sex traditionally has been considered a risk factor for hypovitaminosis D. A few large studies confirm this association.[25] However, some studies found no differences between sex,[24] whereas other studies found that the female sex was associated with a decrease in risk for hypovitaminosis D, and the male sex was identified as a risk factor.[10]

Daily sunlight exposure greater than 30 min had vitamin D sufficiency in 16.3% patients that was better than overall vitamin D sufficiency 8.7%. Effect of sunlight on vitamin D status has been well documented and confirms the importance of sunlight exposure in the synthesis of vitamin D. Area of skin exposed and duration of sunlight exposure strongly correlated with vitamin D levels in this study as shown similarly by other studies.[26] In local population, avoidance of sunlight due to fear of darkening of skin and covering of whole body religiously or only exposing face and hands traditionally especially in female subjects when going outdoor were the main attributing factors. Clothing can exclude varying amounts of UVB radiation depending on the style and colour, and sunscreen with an SPF as low as 8 can exclude up to 95% of UVB radiation.[27] Male subjects also avoid sun exposure not only due to high temperature in summer season in this part of the world but also have misconception regarding harmful effects of sunlight and unawareness regarding the source of vitamin D. In our study, elderly patients were mostly house bound and less mobile due to physical disability and so had less sun exposure and deficient vitamin D level. Although lack of, or limited, sun exposure certainly puts an individual at risk for hypovitaminosis D, sun exposure regardless of latitude, season or length of exposure does not ensure an individual to have a sufficient 25(OH)D concentration.

In our study, we found that BMI levels were constantly inversely related to vitamin D levels. Obesity is a risk factor for hypovitaminosis D. Multiple clinical studies confirm that there is an inverse correlation between body mass index (BMI) and 25(OH)D concentrations.[10] Bogunovic et al. quantified the risk for orthopaedic surgery patients; compared with patients of normal BMI, obese patients were twice as likely to have hypovitaminosis D.[10] Furthermore, the odds of hypovitaminosis D increased by approximately 5% for every unit increase in BMI.[10] However, clinical studies also reveal high rates of hypovitaminosis D among populations that are not obese. Therefore, although the obese are at elevated risk, one should not assume that a nonobese individual is not at risk.

5. Conclusion

Our study states that there is an alarmingly high incidence of vitamin D insufficiency and deficiency likely exists across all age groups among orthopaedic patients. Risk factors for low vitamin D include lack of exposure to sufficient sunlight, inadequate dietary intake and supplementation, and other factors, including obesity, age, medication use, sunscreen use, covering all skin with clothing and skin pigmentation. All orthopaedic patients should be screened as part of their preoperative workup. Postoperative orthopaedic patients that continue to experience musculoskeletal pain should be screened as well. Screening and treating hypovitaminosis D appear to be important in this patient population. Nevertheless, public awareness of vitamin D deficiency needs to be efficiently raised by dedicated, collaborative efforts of concerned clinicians and public health workers.

Conflicts of interest

The authors have none to declare.

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