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Original Research Article

Inadequate vitamin D level: association with low energy fractures of distal radius in young patients and its predictors in Karachi, Pakistan

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ABSTRACT

Background: The objective of the study was to determine association of inadequacy of vitamin D level with low energy fractures of distal radius and its predictors in young patients in Karachi Pakistan.
Methods: Cross-sectional study was conducted on 220 young patients, visited hospital with low energy fracture of distal radius. A questionnaire was designed and filled after taking consent includes details regarding age, gender, occupation, area of skin and sun exposure duration, dietary habits, type of clothing and residence used. Serum Vitamin D3 levels were determined and compared with serum calcium levels, serum phosphorus and alkaline phosphatase levels.
Results: Among 220 patients ranging from 12-45 years, mean 28±23.33 SD. Female were 172 (78.18%). Mostly have history of fall 127 (57.72%) and RTA 63 (28.63). Sun exposure duration in majority of participant was 1-2 hour/day 132 (60%). Variable coloured clothes used by majority participant 135 (61.36%) and variable fabric 102 (46.36%). 202 (91.8%) patients had deficiency of vitamin D and correlated with duration of sunlight exposure significantly, also with exposure of large skin area, dietary consumption of vitamin D rich food and worn variable clothing colours. Serum phosphorus level and serum alkaline phosphatase level were negatively correlated with vitamin D significantly whereas positively correlated with serum calcium.
Conclusions: Prevalence of vitamin D deficiency is very high in low energy fracture of distal radius in young population and sun exposure duration found to be most common predictor of inadequate D levels. A national food fortification program and campaign of public awareness to increase sunlight exposure and increase intake of vitamin D rich food are urgently needed.

Keywords: Low energy, Distal radius, Fracture, Inadequate D level, Sun exposure

INTRODUCTION

Since identification of vitamin D in 1921, this vitamin appreciated for its role in bone health and homeostasis of calcium in body.[1] Vitamin D is fat-soluble vitamin belongs to secosteroids group and it is responsible not only for increasing intestinal absorption of calcium but also magnesium, iron, phosphate and zinc.[2] Natural major source of the vitamin D (specifically cholecalciferol) is synthesis in the skin and very few foods are rich in vitamin D. Duration of sun exposure, specifically UVB radiation is responsible for dermal synthesis of vitamin D from body cholesterol. Probably due to dress and/or cultural habits in many countries those who normally resides in sunny climate areas are found to be vitamin D deficient commonly.[3] If there is limited sunlight exposure

in daily routine, recommended daily intakes of vitamin D are known to be insufficient unfortunately.[4]

The main role of vitamin D and parathyroid hormone is to regulate body calcium metabolism and maintain health of bone. Deficiency of vitamin D in body leads to rickets in children and in adults its deficiency causes osteomalacia.[5] Stimulation of absorption of calcium from the gut is the main effect of the active vitamin D metabolite. Secondary hyperparathyroidism and loss of bone density are the consequences of deficiency of vitamin D, leads to mineralization defects, leading to osteoporosis and fractures, muscle weakness, osteomalacia in adults after long term and, associated fractures by falls.[6] Supplementation of Vitamin D and calcium in study participants shows significant decrease in incidence of fracture showed in several randomized placebo-controlled trials.

Vitamin D deficiency in the older age group and also remains common in children and adults and has become a worldwide epidemic.[5,7] Once there was a thought that vitamin D deficiency in south Asia was in rarity.[8] Prevalence of inadequate vitamin D levels showed to be 90 per cent in study conducted in healthy subjects in Delhi and subsequently showed widespread vitamin D deficiency in participants of all age and gender groups in number of studies conducted from different parts of India.[9-11]

Values of recommendations on recommended serum level of vitamin D vary. Serum levels for vitamin D close to 75 nmol/l appeared to be the most advantageous concluded in a 2014 review.[12] At least 70 nmol/l of vitamin D serum levels should be maintained in order to avoid negative health effects showed report in 2015 review regarding optimal levels, another review have been reported desirable levels of vitamin D between 90-120 nmol/l, but optimal vitamin D levels are still controversial. Ranges from 75 to 100 nmol/l were to be recommended for athletes concluded by the review.[13] The United State labs generally report vitamin D levels as nmol/l often used by other countries. If sunlight exposure is limited by any means then recommended daily intake of vitamin D may not be sufficient.[14]

Insufficient sunlight exposure in daily routine is main cause of Vitamin D deficiency, other causes are diminished vitamin D synthesizing capacity of the skin, or low dietary vitamin D rich food intake.[15] The serum vitamin D circulating level is the most sensitive/reliable marker for vitamin D status of subjects.[16] Severe vitamin D deficiency defined as serum vitamin D level lower than 12.5 nmol/l and moderate as 12.5–25 mol/l.[15] Currently below 50 nmol/l of vitamin D level defined as vitamin D deficiency, this is based on studies on the conducted on association between vitamin D levels with, bone turnover, bone mineral density, muscular function and falls.[15]

In the upper extremity most common site of fracture is the distal radius. Approximately 1/6th of fractures are distal radius fractures treated in United States emergency room departments.[17] Over 1.4 million emergency department visits found in United States annually , of these 1.5 percent of all visits account for hand and forearm fractures and largest portion around 44 % comprises of the fractures of radius or /and ulna.[17] Even though in female osteoporotic population distal radius fractures are more frequently seen, but these fracture are still have high prevalence in young patient populations of both male and female as well.[18,19] Distal radius fractures in vitamin D deficient patient may predict future risks of both hip and vertebral bone fractures subsequently, as on average 15 years earlier distal radius fractures occurs in life than hip fractures.[20-22] It may be clinically appropriate after incidence of low energy distal radius fracture to put more efforts to identifying possible risk factors in such patients, to reduce future hip and vertebral bone fractures risks.

On reviewing published article there is no data in local population on prevalence of vitamin D inadequacy in young patients with low energy distal radius fracture. Other objective was to factor identification within daily lifestyle that represents predictors for inadequate vitamin D level in the study participants.

METHODS

This cross sectional study was conducted in accident and emergency Department of Jinnah Postgraduate Medical Center Karachi, Pakistan from January 2018 to June 2018. Karachi is located at 67° E longitude and 24° N latitude with throughout the year abundant sunshine. During the period of field study, there was no sunshine difference that could affect vitamin D status substantially. 220 patients' age range from 12-45 years, with isolated distal radius fracture included in this study with informed consent.

The exclusion criterion includes patient with polytrauma, with fracture other than distal radius fracture, patient history of diabetes mellitus, any metabolic bone disease, adrenal, thyroid, parathyroid, gonadal disease or malabsorption syndromes, patient with any malignancy, hepatic or renal disease, history of taking vitamin D status affecting medicines e.g., vitamin D supplements, calcium supplements, estrogen, progesterone and antiepileptics, more than one-week immobility and History of pregnancy and lactation.

Questionnaire was designed to determine the demographic data includes age, gender, sex, occupation and details of sun exposed skin area and duration of sun light exposure in previous month, dietary habits, type of clothing and type of residence they used to live.

The vitamin D status of study participant evaluated by the serum vitamin D levels. The reference range for vitamin

D was equal to or >30 ng/ml as normal, vitamin D deficiency was defined as serum vitamin D levels <20 ng/ml while insufficiency defined as a vitamin D level between 20.1-29.9 ng/ml. To get additional information about vitamin D status, serum calcium levels, serum phosphate and serum alkaline phosphatase were also measured. SPSS version 21 used for statistical analysis and statistically significant p value <0.05 was considered.

RESULTS

Among 220 patients, age ranging from 12-45 years, mean 28±23.33 SD. Female were 172 (78.18%). Patients were predominantly married 150 (68%). All patients have low energy distal radius fracture. Mostly have history of fall 127 (57.72%), road traffic accidents (RTA) 63 (28.63), assault 17 (7.7%) and other 13 (5.9%) (Table 1). Exposure of face and hands while outdoor by most of them was 115 (52.2%). Sun exposure duration in majority participant was 1 to 2 hour/day 132 (60%), mostly are resident of apartments 102 (46.36%). Majority participant use clothes of variable colour 135 (61.36%) and variable fabric 102 (46.36%) with p<0.05. 202 (91.8%) participants found deficiency of serum vitamin D levels and was significantly correlated with exposure of sunlight duration, exposure of body skin area, food rich in vitamin D consumption and worn variable clothing colours with p<0.05 (Table 2). Regarding daily dietary habits most of the participant consumed food poor in vitamin D 199 (90.45%) whereas only 21 (9.5%) participants had adequate amount of food rich in vitamin D (Table 2).

Statistically there was no gender difference between male and female regarding vitamin D level. Vitamin D levels in study participant not correlated with age, difference of gender, marital status, residence type used and variable cloth fabrics types significantly.

Serum phosphorus levels and serum alkaline phosphatase level were negatively correlated with vitamin D significantly whereas positively correlated with serum calcium (Table 2).

Table 1: Patient demographics (n=220).

Patient demographics	
Average age (yrs)	12-45
Mean age (SD)	28±23.33SD
Gender, N (%)	
Male	48 (21.82)
Female	172 (78.18)
History of Trauma, N (%)	
Fall	127 (57.72)
RTA	63 (28.63)
Assault	17 (7.7)
Other	13 (5.9)
Marital status, N (%)	
Married	150 (68)
Single	70 (32)

Table 2: Study outcomes (n=220).

Study outcomes	
Vitamin D status, N (%)	
Deficiency <20 µg/ml	202 (91.8)
Duration of sun exposure, N (%)	
<1 hour/day	53 (24)
>1 hour/day	132 (60)
2-4 hour/day	35 (16)
Vitamin D rich food consumption, N (%)	
Poor	199 (90.45)
Adequate	21 (9.5)
Variable clothes colour, N (%)	135 (61.36)
Variable clothes fabrics, N (%)	102 (46.36)
Serum calcium (mg/dl)	
Minimum	7.6
Maximum	10.6
Mean	8.62±0.68
Serum phosphate (mg/dl)	
Minimum	2.4
Maximum	6.6
Mean	3.61±0.79
Serum alkaline phosphatase (IU/l)	
Minimum	39
Maximum	366
Mean	146.4±75.21

DISCUSSION

Our study show high percentage of low vitamin D levels in study participant presenting with low energy distal radius fracture. Previous reports also demonstrate low vitamin D levels in healthy individuals from various regions of Pakistan.[23-25] Regional studies conducted in Pakistan shows prevalence of serum low levels of vitamin D in ambulatory patients from centers in Karachi found approximately 92% and in Lahore approximately 81%.[26,27] The prevalence of serum vitamin D level deficient has been reported as 41.1% including 10.1% of severe cases and 31% deficient cases among children shown in Pakistan National Survey.[28]

In general population, there are many contributory factors to the deficiency of vitamin D worldwide, these includes reduced sunlight exposure, cutaneous age linked reduction in vitamin D synthesis, and reduce intake of vitamin D rich food. New global epidemic is deficiency of vitamin D among both children and adult population world-wide.[29] Our results of vitamin deficiency are also supported by a national data which showed vitamin D deficiency in 77.5% study participant whereas in the category of vitamin D insufficiency were 18%, reported in study from Faisalabad, Pakistan.[30] Another study showed 90.1 % vitamin D deficiency in young premenopausal female participant conducted in Karachi.[31]

The deficiency of vitamin D in the United States has been found to be 36% in adults study participant while in general medicine patients found up to 57%.[32] Therefore, in the USA vitamin D deficiency is now recognized as an epidemic.[33] One in three Australians as Vitamin D deficient indicated in a report from Australia.[34]

The prevalence of deficiency of vitamin D highly attributed to dietary factors, exposure avoidance and limitation of sunlight, multiparity, clothing colour and fibre factors, and degree of air pollution in atmosphere which prevents penetration of enough UVB rays.[11,35-38]

The number of cases in Pakistan is on the rise with deficiency of vitamin D but government authorities or by the individuals has not given any due attention to this issue. The lack of awareness of maintaining required level of serum vitamin D and basic knowledge of general population this problem is further compounded.

Another determinant of our study was dietary factor responsible for high prevalence of inadequate vitamin D levels. Consumption of low amount of food which are rich in vitamin D by most of our participants observed in our study. Due to lack of awareness regarding quantity of diet consumed and composition of food database for vitamin D unavailable in Pakistan, true estimation regarding consumption of vitamin D containing food was not possible. Currently Pakistan does not have any type of mandatory vitamin D fortification policy, unlike many western countries that have a mandatory food fortification policy regarding vitamin D. The major source of vitamin D synthesis in body is UVB rays exposure through sun light to the skin. After 10 to 15 minutes exposure at least two times/week of sun light to the face, arms, hands, or back skin results in synthesis of adequate amounts of vitamin D. After longer exposure to UVB rays, equilibrium is achieved in the skin and the vitamin D simply degrades as fast as it is generated. Prolonged sun exposure is required in increased pigmentation, sun block usage, observation of purdah (covering of body parts) and women in this region generally do not go outside of residence, this may responsible for deficiency of vitamin D. In local population when going outdoor sun exposure avoidance to prevent darkening of skin and religiously only exposing face and hands or covering of whole body traditionally especially in female mostly among house wives who are mostly involved in domestic work found to be main attributing factors. Male participant also avoid sun exposure not only due to summer high temperature, but also having misconception of harmful effects of sunlight and lack of awareness regarding vitamin D sources.

In Pakistan black clothes wear by women in significant percentage traditionally/religiously for pardah while going outdoors. It has been found that black wool attenuate most of UVB rays and least by white cotton previously.[39]

Air pollution is also another attributing factor of vitamin D deficiency.[38] The air pollution could be an factor attributing vitamin D level in study participants because Karachi is among one of the world's highly polluted cities but evaluation of air pollution effects was beyond our study scope.

Despite abundant sunlight throughout the year prevalence of deficiency of vitamin D was surprisingly high (91.8%) among patient with fracture of distal radius in Karachi. fractures of distal radius may predicts future risk of both hip and vertebral bone fractures subsequently, as on average 15 years earlier fractures of distal radius occurs in life than hip fractures.[20-22] It may be clinically appropriate after first incidence of low energy fracture of distal radius to put more efforts to identify risk factors in such patients, to reduce future hip and vertebral bone fractures risks.

Unfortunately no local data found on prevalence of vitamin D deficiency in low energy fracture of distal radius in local population. Study conducted in Norway on low energy fracture of distal radius in adult patient's shows high level of vitamin D deficiency.[40]

Limitation

Local data of low energy fracture of distal radius associated with vitamin deficiency is not available and limited study done on this topic worldwide. Due to several reasons unable to calculate vitamin D daily dietary intake. Rainy days and Overcast also ignored during study period due to limitation of resources serum paratharmone levels did not checked.

CONCLUSION

Prevalence of vitamin D deficiency is very high in low energy fracture of distal radius in young population and sun exposure duration found to be most common predictor of inadequate D levels. To combat this epidemic the Government support and commitment are needed. A national food fortification program of vitamin D and campaign of public awareness to increase sunlight exposure and increase intake of vitamin D rich food are urgently needed.

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