ISSN: 0975-1556

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2021; 13(4); 01-07

Original Research Article

A Case Control Study to Determine the Frequency and Severity of Vitamin D Insufficiency in People with Type 2 Diabetes

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Received: 18-05-2021 / Revised: 21-06-2021 / Accepted: 29-07-2021
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Conflict of interest: Nil

Abstract

Aim: The aim of the study to assess the prevalence and severity of vitamin D deficiency in type 2 DM. **Methods:** A case-control study was conducted in the Department of General Medicine, Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar, India, for 15 months. Total 220 participants were including in the study out of which 110 healthy people were include as case (Group A) and 110 type 2 diabetic patients as controls (Group B). Routine laboratory Investigations like CBC, FBS, RBS, PP2BS, HbA1C, blood urea, serum creatinine, lipid profile, urine albumin and Vitamin D3 levels were done by standard methods in central laboratory of Institute. **Results:** The mean age of group A (case) was 51.88±11.36 years while that of group B (control) was 49.92±11.26 years. Total 115 males and 105 females were enrolled in study. 64.55% of group A were male and 35.45% female. Group B (control) had 59.10% males and 40.90 female. Prevalence of low vitamin D level in healthy population was only 22.73 % in my study, while prevalence was 86.36 % in Diabetic group. Among diabetic patients having abnormal Vitamin D level, majority (66.36%) were having insufficiency, only 22% were having overt vitamin D deficiency in Diabetic patients. In patients with controlled diabetes as per HbA1C criteria, the prevalence of sufficient, Insufficient and Deficient Vitamin D was 20.41%, 69.39% and 16.33% respectively, where in patients with uncontrolled diabetes it was 8.20%, 68.85% and 22.95% respectively. More number of diabetic patients with uncontrolled status (22.95%) was having overt vitamin D deficiency in comparison to controlled status (16.33%). There is a significant association between the maintenance of euglycemia and severity of Vitamin D level in diabetic patients, as the p value is less than 0.05. Hypertension was most common co-morbidity found in diabetic group (18.18%) followed by ischemic heart disease (4.54%). **Conclusion:** We concluded that the control of diabetic status is mandatory in order to prevent vitamin D deficiency.

Keywords: Serum vitamin D level, Type 2 diabetes mellitus, Vitamin D deficiency.

Introduction

Vitamin D deficiency is highly prevalent worldwide[1]. Serum 25-hydroxy-vitamin D3 (25(OH)D) is a better indicator of vitamin D sufficiency than the active hormone, that is, 1,25-dihydroxy-vitamin D3[2]. Therefore, the serum concentration of 25(OH)D is widely accepted as a good indicator of the status of vitamin D in a given subject. The main biological actions of vitamin D include the maintenance of mineral homeostasis and the regulation of bone remodelling[1]. However, there is a

vast array of pleiotropic actions of this vitamin that were already recognized more than two decades ago[2].

Although the number of people with T2DM is increasing in every country, its major contribution is from developing countries, where it is fast becoming an epidemic. Due to the increasing global burden of T2DM, the pathophysiology of this disease is being explored with renewed interest. Insulin resistance and β-cell failure are the core pathophysiologic defects of T2DM. It is primarily due to interplay between genetic and environmental factors. Incidence of T2DM varies from one geographical region to another due to differences in lifestyle and risk factors. Apart from conventional environmental risk factors like obesity, physical inactivity, intake of high calorie food and stress, the role of certain nutritional factors in pathogenesis of T2DM is an emerging concept at present. Accumulating evidence from several cross-sectional studies suggests that vitamin D has an important role in the homeostasis of blood glucose, and its deficiency may cause development of T2DM. Vitamin D, originally described merely as a vitamin, is indeed a misnomer as it is now well-established that its active form is a hormone which is not only involved in bone metabolism but also in a plethora of non-skeletal physiological processes. Several mechanisms have been proposed, indicating a positive effect of vitamin D on insulin secretion and sensitivity, which include its direct effect via activation of vitamin D receptor on pancreatic β-cells and insulin sensitive organs and indirect effect via regulation of calcium homeostasis[3]. In the largest epidemiological study from the NHANES population, a dose-dependent inverse relationship has been observed between vitamin D and type 2 DM with the highest number of metabolic syndrome patients having the lowest quartiles of vitamin D[4]. The main source of vitamin D in humans is exposure to sunlight, natural diet and dietary supplements. Vitamin D from the skin and diet are metabolised in the liver to 25- hydroxy vitamin D [25 (OH)D] which is used to determine the patient's vitamin D status. Although there is no definite consensus about the normal level of vitamin D, most experts define vitamin D deficiency as less than 20 ng/ml. A level of 20 - 29 ng/ml is considered to indicate a relative insufficiency of vitamin D and a level of 30 ng/ml or greater can be considered as sufficient[5,6]. According to this definition, 1 billion people worldwide are suffering from vitamin D deficiency or insufficiency. Even in the sunniest countries including India, vitamin D deficiency is very common as most of the body surface is shielded from the sun. India is a country where both T2DM and hypo-vitaminosis D are prevalent. But relatively scarce data is available observing the correlation between the two. The aim of the study to assess the prevalence and severity of vitamin D deficiency in type 2 DM.

Material and methods

A case-control study was conducted in the Department of General Medicine, Lord Buddha Koshi Medical College and Hospital, Saharsa, Bihar, India, for 15 months, after taking the approval of the protocol review committee and institutional ethics committee.

Methodology

Total 220 participants were including in the study out of which 110 healthy people were include as case (Group A) and 110 type 2 diabetic patients as controls (Group B). Controls include age and sex matched healthy individuals. Patients with chronic kidney disease, patients taking calcium supplements or vitamin D supplements within last 3 months, patients suffering from any known chronic illness were excluded from this study. Routine laboratory Investigations like CBC, FBS, RBS, PP2BS, HbA1C, blood urea, serum creatinine, lipid profile, urine albumin and Vitamin D3 levels were done by standard methods in central laboratory of Institute. The value of serum vitamin D level was

further divided in following category: sufficient = 30-100ng/ml, insufficient=20-29ng/ml, deficiency = less than 20ng/ml.

Results

In the study population, the mean age of group A (case) was 51.88±11.36 years while that of group B (control) was 49.92±11.26 years. Total 115 males and 105 females were enrolled in study. 64.55% of group A were male and 35.45% female. Group B (control) had 59.10% males and 40.90 female. On evaluation of investigation profile of both group A and group B, mean values of haematological parameters in form of haemoglobin, total count and platelet were within normal limit and comparable in both groups. Surprisingly mean value of renal function test parameters, blood urea and serum creatinine were within normal range for diabetic group also, though 10% of patients had abnormal serum creatinine value and it range from 2.22 to 4.2 mg/dl.

Mean value of all lipid profile component was in normal limit in both the group, but 37.27% of diabetic patients had dyslipidaemia and commonest dyslipidaemia was hyper-triglyseridemia in 31.82% patients. Frequency Distribution of Participants according to Severity of Vitamin D level noted. Prevalence of low vitamin D level in healthy population was only 22.73% in my study, while prevalence was 86.36% in Diabetic group. Among diabetic patients having abnormal Vitamin D level, majority (66.36%) were having insufficiency, only 22% were having overt vitamin D deficiency in Diabetic patients (table 1.)

Table 1: Severity grading of vitamin d deficiency in cases and controls

	Case =110	%	Control=110	%
Deficiency	22	20	00	0.00
Insufficient	73	66.36	25	22.73
Sufficient	15	13.64	85	77.27

Table 2: The association of severity of vitamin D level with the category of diabetes control

Diabetes Control	Vitamin D Level			Chi Sq (p value)
	Sufficient	Insufficient	Deficiency	
Controlled Diabetic (N = 49)	10 (20.41%)	31 (69.39%)	8 (16.33%)	2.94
Uncontrolled Diabetic (N= 61)	5 (8.20%)	42 (68.85%)	14 (22.95%)	(0.004)

In patients with controlled diabetes as per HbA1C criteria, the prevalence of sufficient, Insufficient and Deficient Vitamin D was 20.41%, 69.39% and 16.33% respectively, where in patients with uncontrolled diabetes it was 8.20%, 68.85% and 22.95% respectively. More number of diabetic patients with uncontrolled status (22.95%) was having overt vitamin D deficiency in comparison to controlled status (16.33%). There is a significant association between the maintenance of euglycemia and severity of Vitamin D level in diabetic patients, as the p value is less than 0.05 (Table 2).

Pearson correlation test showed negative correlation between HbA1C level and mean vitamin D level in Diabetic group as r = -0.277, p value = <0.001. It suggests as HbA1c level increase, the level of vitamin D decreases, so more severe the hyperglycaemia and poorer the control of diabetes status, there was more severe the vitamin D deficiency. We also compare the mean value of vitamin D deficiency with

the duration of Diabetes, but there was no significant relation between duration of diabetes and serum vitamin D deficiency (P value >0.5).

Diabetic nephropathy was the most common micro vascular complication seen in type 2 diabetic patients. it was found that all three important microvascular complications: - diabetic retinopathy, diabetic nephropathy and peripheral neuropathy did not have any significant correlation with serum Vitamin D level as p value is greater than 0.05 for all three parameters (Table 3).

Table 3: Comparison of mean vitamin D level with duration and micro vascular complication of diabetes mellitus

	Parameters		Mean value of vitamin D (ng/dl)	p value
	0-5 years		26.21±6.63	
Duration of diabetes	5-10 years		28±5.67	0.29
	>10 years		25.94±3.77	
Micro-vascular complication	Diabetic	Present	23.93±5.21	
	retinopathy	Absent	27.07±5.74	0.084
	Diabetic	Present	29.23±5.63	
	nephropathy	Absent	26.76±6.69	0.061
	Peripheral	Present	25.29±4.87	
	neuropathy	Absent	28.36±5.79	0.121

Hypertension was most common co-morbidity found in diabetic group (18.18%) followed by ischemic heart disease (4.54%). Serum vitamin D level was measured in all participants. 86.36 of diabetic population was having less than normal vitamin D level, while only 22.73% had less than normal vitamin D level in group B(control). Mean value of vitamin D in type 2 Diabetic patients was 27.83±6.87 ng/dl and mean value of vitamin D in healthy individuals was 36.21±4.79 ng/dl.

Table 4: Subgroup analysis- mean vitamin D level in diabetes patients in relation with age, gender and associated co-morbidities

Parameters (Number of patients)		Mean value of vitamin D	p value
Age group	Below 35 (86)	26.32±5.65	
	Above 35 (24)	26.02±3.49	0.271
Gender	Male (71)	29.15±5.26	
	Female (39)	26.12±4.38	0.028
HTN	Yes (20)	22.36±4.72	
	No (90)	26.38±6.51	0.037
IHD	Yes (5)	29.23±4.42	
	No (105)	27.27±5.52	0.131

Discussion

The literature on the role of 25(OH) vitamin D in vascular calcification is ambiguous. Experimentally higher 25(OH) vitamin D level have been associated with increased vascular calcification while in vivo, lower level of 25(OH) vitamin D seems to have this effect. This suggests that 25 (OH) vitamin D may have a biphasic relation with risk promoting Vascular Calcification in both excess and deficiency[7].

However, the prevalence of vitamin D deficiency in India is around 50-90% in normal healthy population[8]. In our study, prevalence of vitamin D deficiency is 22.73% in normal population which is

similar to worldwide prevalence but very less in comparison to prevalence shown in Indian studies. This low prevalence in healthy population was contradictory to other Indian studies. Another on-going study on vitamin D level done in similar region had also showed 16% prevalence of vitamin D deficiency in healthy population. Vitamin D exerts its effect on calcium metabolism and hence affects skeletal system; however, it also has extra skeletal effects like that on cardiovascular system, endocrine disorders and autoimmune disorder. Several reports have ascribed an active role to vitamin D in the functional regulation of the endocrine pancreas, particularly the beta-cells.

India is already declared as 'Capital of Diabetes'. Diabetes mellitus is accepted as major emerging epidemic in India, as India is having 41 million of diabetic patients currently and it will go up to 70 million by year 2025. As vitamin D has been showed to have effect on pathophysiology of diabetes and have very high prevalence of vitamin D deficiency, so we have taken up this study to see effect of both high prevalence diseases on each other.

Various studies done in different geographical region and cultural background have shown varied range of prevalence of vitamin D deficiency in diabetic group ranging from 67%-98.8%[8-11]. Our study along with Bashir et al and Ifigenia-Kostoglou A et al studies had shown higher prevalence of vitamin D deficiency in diabetes mellitus patients compared to healthy individuals, but two other studies had shown no difference of prevalence between diabetic and healthy population[8-11]. So, we have compared the mean value of serum vitamin D level in diabetic patients and in healthy population of various study. Various studies including our study had low mean level of vitamin D for diabetic patients in comparison to healthy population[8,11,12].

In patients with controlled diabetes as per HbA1C criteria, the prevalence of sufficient, Insufficient and Deficient Vitamin D was 20.41%, 69.39% and 16.33% respectively, where in patients with uncontrolled diabetes it was 8.20%, 68.85% and 22.95% respectively. More number of diabetic patients with uncontrolled status (22.95%) was having overt vitamin D deficiency in comparison to controlled status (16.33%). There is a significant association between the maintenance of euglycemia and severity of Vitamin D level in diabetic patients, as the p value is less than 0.05. Similar results was shown by Mukherjee B et al. Mean level of vitamin D is low in uncontrolled diabetic patients (19.47±4.76) as compared to controlled diabetic patients (23.63±3.71)[12]. Modi KD et al found that vitamin D levels in patients with controlled diabetes was 22.4±18.6 while in uncontrolled diabetic patients it was lower, 19.9±18.3 which is statistically significant[13]. Overall insufficiency is more common than deficiency state in diabetic patients regardless of diabetic control status, but severe vitamin D deficiency is more prevalent when patients were having uncontrolled diabetes than controlled diabetes (22.95% and 16.33% respectively). On Pearson correlation, the study has demonstrated negative correlation between HbA1C level and serum vitamin D level. It is suggesting that as HbA1C level increase, there is decrease in serum vitamin D level. Ifigenia-Kostoglou A et al had also found that 25(OH) D3 levels were inversely associated with HbA1c when the patient and control groups were analysed together ($p = 0.008$, $r^2 = 0.058$, linear regression analysis)[11]. Study by Mukherjee B et al also indicates there is a definite negative correlation between Vitamin D levels and diabetes (r= -0.94 and -0.97) and poorly controlled diabetics have further lower values of Vitamin D[12]. A study by Akshay kumar SV et al showed a negative negligible co-relation between vitamin D levels and HbA1C, which was not statistically significant (r = 0.017, p value 0.741)[10].

The inverse relationship between vitamin D level and glycaemic control in this study support an active role of vitamin D in pathogenesis of type 2 diabetes mellitus.

Duration of diabetes and presence of micro-vascular complication do not have effect on serum vitamin D level. No effect of increasing age was observed on vitamin D status in diabetic patients and we could not able to find such association in other studies. Female diabetic patients were having lower vitamin D level compared to male counterparts; the reason might be less exposure to sun due to household activity. Hypertension was the most common comorbidity found in diabetic patients (18.18%) in our study. Study by Shalini P et al found that Vitamin D deficiency is more prevalent (80.4%) in hypertensive patients than healthy (67.7%) individuals[14]. Hypertensive diabetic patients had lower vitamin D level than non-hypertensive diabetic patients in my study, which is statistically significant as p value was 0.037. Ischemic heart disease was another comorbidity found with diabetes, but there was no significant difference in mean Vitamin D level was recorded in diabetic patients with or without ischemic heart disease.

Conclusion

Present study supports the proposition that vitamin D deficiency is more dominant in diabetic foot infection. Wound healing is impaired in diabetic patients while vitamin D is essential for a normal functioning immune system. The most active vitamin D metabolite, 1,25- dihydroxyvitamin D3, induces antimicrobial peptides production in keratinocytes from diabetic foot ulcers. This study opens up an issue of recognizing vitamin D deficiency as a possible risk factor for diabetic foot infections and suggests the need for vitamin D supplementation in such patients to prevent or to adjuvant the antibiotic therapy for control of infection. Our data also raise the possibility that 25(OH)D might provide an adjunctive method for early detection of risk for foot complications in diabetes.

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