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Association between Vitamin D Level and Blood Pressure Control in Patients with Hypertension in Family Medicine Clinics of King Abdulaziz National Guard Hospital, Al Ahsa, Saudi Arabia in 2017

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Abstract: ***Objective: This study aimed to determine the prevalence of vitamin D deficiency in patients with hypertension and investigate the association between vitamin D level and blood pressure control. Methods: A cross-sectional study was conducted on patients with hypertension who visited family medicine clinics of King Abdulaziz National Guard Hospital, Al Ahsa, in 2017. Data were collected through self-administrated questionnaire that included both demographic and lifestyle factors with blood pressure and vitamin D level, which were measured through a medical chart review. Results: Of the 246 patients who participated in the study, 51.6% had uncontrolled hypertension. Current intake of vitamin D was noted in 56.9% of patients with hypertension. A majority of patients with hypertension (78.6%) had vitamin D insufficiency, whereas 10% had vitamin D deficiency. There was a statistically significant mild negative correlation between systolic blood pressure (SBP) and vitamin D level (r=-0.14, p=0.04). Conclusion: Vitamin D insufficiency/deficiency is particularly common among patients with hypertension, with mild negative correlation between vitamin D level and SBP. It is recommended to maintain optimal vitamin D level to control blood pressure.***

Keywords: Vitamin D deficiency, Vitamin D insufficiency, Hypertension, Obesity

1. Introduction

Vitamin D is a fat-soluble vitamin that is naturally present in few foods and available as a dietary supplement. It is also endogenously produced when ultraviolet rays from sunlight penetrate the skin and trigger vitamin D synthesis [(1)]. Vitamin D promotes calcium absorption in the gut and maintains adequate serum calcium and phosphate levels for normal bone mineralization and prevention of hypocalcemictetany. It is also needed for bone growth and remodeling by osteoblasts and osteoclasts [(1)].

Hypertension is a condition in which the blood vessels have persistently increased pressure, subjecting them to increased stress. Normal adult blood pressure (BP) is defined as a BP of 120 mmHg when the heart contracts (systolic) and 80 mmHg when the heart relaxes (diastolic). A systolic BP (SBP) ≥140 mmHg and/or diastolic BP (DBP) ≥90 mmHg is considered increased or high BP [(2)].

In adults, vitamin D deficiency is defined as a serum 25-hydroxyvitamin D level <20 ng/mL (50 nmol/L), and vitamin D insufficiency is defined as a serum 25-hydroxyvitamin D level of 20–30 ng/mL (50–75 nmol/L) [(3)].

Studies reported that 25-hydroxyvitamin D level is strongly associated with hypertension and hypertension is caused by an increase in BP [(4)]. Lower vitamin D level is associated with higher BP and can potentially increase the risk of hypertension [(4)]. In the primary care setting, hypertension is the most common condition that leads to myocardial infraction, stroke, renal failure, and death, if not detected early and treated appropriately [(5)]. The prevalence of hypertension is increasing in Saudi Arabia and affecting >25% of the adult Saudi population [(6)]. In 2014, the prevalence of vitamin D deficiency in Saudi Arabia was 78.1% in women and 72.4% in men [(7)].

The current study attempted to assess the vitamin D level and other lifestyle factors in patients with hypertension and answer the following question: "Is there an association between vitamin D level and SBP in patients with hypertension?" Therefore, this study was conducted to determine the prevalence of vitamin D deficiency in patients with hypertension who visited family medicine clinics and investigate the association between vitamin D level and BP control.

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2. Materials and Methods

A cross-sectional study was conducted in 2017 at the Family Medicine Department, King Abdulaziz National Guard Hospital, Al Ahsa, Saudi Arabia. One proportion equation was used for sample size calculation, assuming that the proportion of patients with vitamin D deficiency in the Saudi population was 78% [5], type I error was 5% ($Z_{a/2}$=1.96), and accuracy of proportion estimate (*d*) was 5%. Hence, the calculated sample size was 246.

$$N = (Z_{a/2})^2 p(1-p) / d^2 = 1.96^2 * (0.78*0.22) / 0.05^2 = 264$$

To collect the sample, study investigators coordinated with patient services employees who received all patients. They were informed about the purpose of the study and were explained how to answer and how and when to distribute and collect the questionnaires from the patients. They were also instructed to ask the patients during registration about the presence of hypertension. Every other patient with hypertension was included to generate randomness in the sample collection process. Hence, the inclusion criteria were confirmed hypertension and age of at least 18 years.

Data was collected through a self-designed questionnaire based on some previous studies. The study questionnaire had the following two main sections: (1) self-administered Arabic questions, including personal characteristics, such as age, sex, and lifestyle characteristics (e.g., physical activity, nutrition, and smoking); medical history; and compliance to medications and (2) chart review, which was filled by the investigator from the BESTCare system and included the SBP and DBP during the last vitamin D level laboratory request, other comorbidities, and the most recent vitamin D level.

Ethical approval for the study was obtained from the Saudi Council for Health Specialties after reviewing the study proposal. After obtaining ethical approval, Family Medicine and Patient Services departments were requested to provide an access to patient files. The purpose of the study was explained to the patients, and written consent was obtained before providing the questionnaire to them. Participation was voluntary, and anyone can refuse participation.

Data was collected, cleaned, coded, and analyzed using Statistical Package for Social Sciences (version 21) software. Categorical data were expressed as frequency and percentage, whereas continuous variables were presented mean and standard deviation. The chi-square test was used to evaluate the association between categorized BP and possible associated factors, including categorized vitamin D level. Pearson correlation was used to find the association between SBP and vitamin D level. The level of statistical significance was determined at P=0.05.

3. Results

A total of 246 patients with hypertension were included in the study. BP control (SBP ≤140 mmHg) was noted in 48.4% of the patients. Table 1 summarizes the general characteristics of patients with hypertension. More than half of patients (51.5%) were aged ≤60 years, and men represented 59.2%. Almost half (47.2%) of the patients were illiterate, whereas 17.1% were highly educated. Most patients (76.8%) had diabetes, and 30.1% had dyslipidemia. A family history of hypertension was reported in 58.2%. Regarding time since hypertension diagnosis, 43.5% of patients reported ≥ 10 years. Current intake of vitamin D was noted in 56.9% of patients. A majority of patients (78.6%) had vitamin D insufficiency, whereas 10% had vitamin D deficiency.

Table 2 presents the association of the general characteristics of patients with hypertension and BP control. None of the studied variables were significantly associated with SBP, although higher uncontrolled BP (SBP >140 mmHg) was reported in patients aged >60 years (57%), female patients (53%), and illiterate patients (56%) compared to their counterparts. Patients who were diagnosed ≥10 years were more likely to have uncontrolled hypertension compared to those diagnosed more recently (<5 years) (55% versus 44%). However, the difference was not statistically significant. Moreover, vitamin D intake and level were not significantly associated with SBP.

Table 3 shows the association between lifestyle characteristics of patients with hypertension and SBP. Regarding body mass index, almost two-thirds (67.9%) of severely obese patients had SBP >140 mmHg compared to 23.5% of underweight patients (P=0.04). As shown in Table 4 and Figure 1, there was a mild negative correlation between SBP and vitamin D level (r=-0.14, P=0.04), which is statistically significant.

Table 1: General characteristics of patients with hypertension (No. 246)

Item	*Categories*	*No.*	*%*
Age (Missed 11)	≤60 years	121	51.5%
	>60 years	114	48.5%
Sex (Missed 1)	Male	145	59.2%
	Female	100	40.8%
Educational level	Illiterate	116	47.2%
	Low	88	35.8%
	High	42	17.1%
Chronic diseases	DM	189	76.8%
	Dyslipidemia	74	30.1%
	Family history (Missed 2)	142	58.2%
SBP	>140 mmHg	127	51.6%
	≤140 mmHg	119	48.4%
Time of HTN diagnosis (Missed 16)	<5 years	75	32.6%
	5–9 years	55	23.9%
	≥10 years	100	43.5%
Vitamin D intake	Yes, currently	140	56.9%
	Yes, previously	34	13.8%
	No	72	29.3%
Vitamin D level (Missed 17)	Deficiency	23	10%
	Insufficiency	180	78.6%
	Sufficiency	26	11.4%

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Table 2: Distribution of general characteristics of patients with hypertension based on systolic blood pressure (mmHg)

Item	Categories	SBP >140		SBP ≤140		P-value	OR
		No.	%	No.	%		
Age (Missed 11)	<60 years*	56	46.3%	65	53.7%	0.1	1.5
	>60	65	57%	49	43%		
Sex (Missed 1)	Male	74	51%	71	49%	0.7	0.9
	Female*	53	53%	47	47%		
Educational level	Illiterate	65	56%	51	44%	0.07	2.9
	Low	47	53.4%	41	46.6%		2.9
	High*	15	35.7%	27	64.3%		1
Diabetes mellitus	Yes	97	51.3%	92	48.7%	0.9	0.9
	No	30	52.6%	27	47.4%		
Dyslipidemia	Yes	37	50%	37	50%	0.7	0.91
	No	90	52.3%	82	47.7%		
Family history of HPN (Missed 2)	Yes	66	46.5%	76	53.5%	0.057	0.6
	No	60	58.8%	42	41.2%		
Time of HTN diagnosis (Missed 16)	<5 years	33	44%	42	56%	0.34	0.7
	5–9 years*	29	52.7%	26	47.3%		1
	≥10 years	55	55%	45	45%		1.1
Vitamin D intake	Yes, currently	71	50.7%	69	49.3%	0.9	0.92
	Yes, previously	18	52.9%	16	47.1%		1
	No*	38	52.8%	34	47.2%		1
Vitamin D level (Missed 17)	Deficiency*	16	69.6%	7	30.4%	0.2	1
	Insufficiency	89	49.4%	91	50.6%		0.43
	Sufficiency	12	46.2%	14	53.8%		0.38

*Chi-square test

Table 3: Distribution of lifestyle factors in patients with hypertension based on systolic blood pressure (mmHg)

Item	Categories	SBP >140 (127)		SBP ≤140 (119)		Total	P-value	OR
		No.	%	No.	%			
Fruit and vegetables per week	No*	16	64%	9	36%	25	0.08	1
	1–3	69	55.6%	55	44.4%	124		0.71
	≥4	42	43.3%	55	56.7%	97		0.43
Meals/day	1– 2*	66	58.4%	47	41.6%	113	0.05	0.6
	3–4	61	45.9%	72	54.1%	133		
Unhealthy food	Usually*	6	37.5%	10	62.5%	16	0.5	1
	Sometimes	70	52.2%	64	47.8%	134		1.8
	Never	51	53.1%	45	46.9%	96		1.9
Nutritional diet	Usually*	10	38.5%	16	61.5%	26	0.4	1
	Sometimes	50	53.8%	43	46.2%	93		1.9
	Never	67	52.8%	60	47.2%	127		1.8
Heavy physical activity/weak	Yes*	11	45.8%	13	54.2%	24	0.6	1.3
	No	116	52.3%	106	47.7%	222		
Moderate physical activity/weak	No	90	56.3%	70	43.8%	160	0.05	2.2
	<150 min	19	51.4%	18	48.6%	37		1.8
	≥150 min*	18	36.7%	31	63.3%	49		1
Gym membership	Yes *	9	52.9%	8	47.1%	17	0.9	0.94
	No	118	51.5%	111	48.5%	229		
Sleep hours/day	<6 h	48	57.1%	36	42.9%	84	0.2	2.67
	6–8 h	73	50.7%	71	49.3%	144		2.06
	>8 h*	6	33.3%	12	66.7%	18		1
Tobacco use	No	113	53.8%	97	46.2%	210	0.25	2.04
	Previously	10	40%	15	60%	25		1.17
	Yes*	4	36.4%	7	63.6%	11		1
Coffee drink/day (Missed 2)	Never*	10	47.6%	11	52.4%	21	0.9	1
	1–2 times	60	52.2%	55	47.8%	115		1.20
	≥3 times	56	51.9%	52	48.1%	108		1.18
Medication compliance	Usually	92	53.2%	81	46.8%	173	0.5	1.2
	Never/sometimes*	35	47.9%	38	52.1%	73		
Appointments compliance	Usually	90	52%	83	48%	173	0.8	1.1
	Never/sometimes*	37	50.7%	36	49.3%	73		
BMI (Missed 2)	Underweight*	4	23.5%	13	76.5%	17	0.04	1
	Healthy weight	35	55.6%	28	44.4%	63		4.1
	Overweight	44	53%	39	47%	83		3.7
	Obese	23	43.4%	30	56.6%	53		2.5
	Severely obese	19	67.9%	9	32.1%	28		6.9

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Table 4: Correlation between systolic blood pressure (mmHg) and vitamin D level (mcg) in patients with hypertension

Item	Mean	SD	P-value	R	R^2
SBP	140.9	20.4	0.04	-0.14	0.02
Vitamin D level	47.3	20.9			

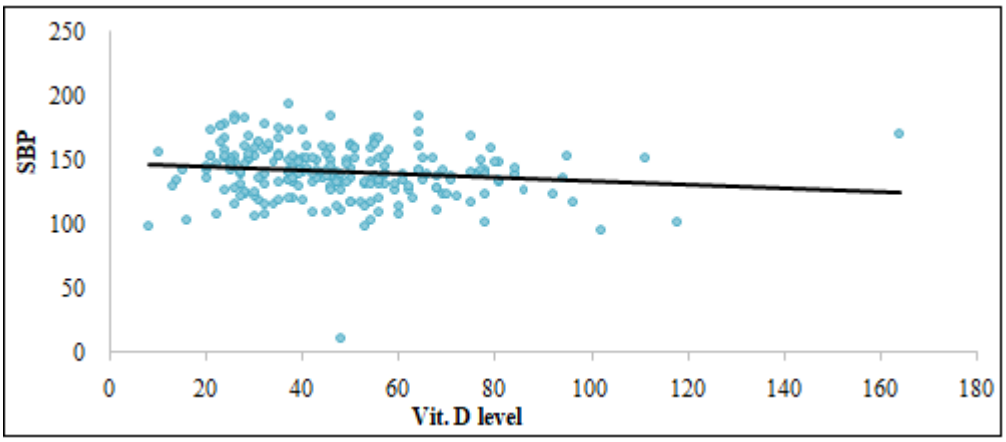

Figure 1: Scatter plot elaborates of corelation between SBP and Vit. D level for hypertensive patients (r= -0.14)

4. Discussion

There is no consensus on the association between vitamin D deficiency and BP as some studies have reported an association between vitamin D deficiency and high BP[8].However, other studies did not find such association [9].

In Saudi Arabia, both vitamin D deficiency [10] and hypertension [6] are common health problems. Therefore, the present study aimed to determine the prevalence of vitamin D deficiency in patients with hypertension and investigate the association between vitamin D level and BP control.

Current study results revealed that higher BP (>140 mmHg) was more frequently reported in patients aged >60 years, female patients, and those with low educational level, although the difference was not statistically significant. Another study from Saudi Arabia in 2007 reported higher prevalence of hypertension in women compare to that in men, and the association was found between education and prevalence of the disease [6].

Many medical conditions can be treated or controlled through diet. Hypertension is one of these conditions [11]. However, this was not proven in the current study. Further study with more details is recommended to clarify this possible association.

One of the important findings of this study was the significant association between obesity and high SBP (>140 mmHg). It is well established that obesity is the root cause of several diseases, including hypertension [12].

The current study revealed that a majority of patients with hypertension (88.6%) had vitamin D insufficiency/ deficiency, and there was a significant negative correlation between vitamin D level and SBP in these patients. This finding is consistent with those of other studies [13-16],but some researchers did not confirm such association [17]. Martins et al. analyzed >15000 individuals and found lower vitamin D level in patients with hypertension compared to that in healthy individuals [14].

The most prominent strength of the current study is investigating various parameters that could influence BP control, including details of patients' diet, daily activities, smoking, and other factors related to patients' health. Additionally, it included information on vitamin D intake and deficiency and their relationship to BP control. However, this was not a multicenter study; hence, the results cannot be generalized on the entire hypertensive population in Al Ahsa. Moreover, it has a cross-sectional design, which is considered as a descriptive study, and the result was not adjusted. Finally, the present study did not include calcium intake in the form of dietary products.

5. Conclusion

Vitamin D insufficiency/deficiency is particularly common in patients with hypertension with negative correlation between vitamin D level and SBP. It is recommended to maintain optimal vitamin D level to control BP. It is also suggested to keep BMI within normal range to prevent high uncontrolled BP. Patients require education on the importance of regular visits to their physician to monitor vitamin D level and BP. Finally, further multicenter study is recommended to obtain a more comprehensive image of the situation in Al Ahsa city.

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