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Assessment of 25-Hydroxy Vitamin D and Serum Electrolytes in Myocardial Infarction Patients with Acute ST-Segment Elevation

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ABSTRACT

Background: Worldwide, acute myocardial infarction was linked with increased morbidity and mortality rates in hospitalized patients. Several previous researches reported consistent evidence of possible relationship between the level of vitamin-D and cardiac disease. The aim of this study was to examine the level of 25-hydroxy vitamin-D and serum electrolytes in patients with myocardial infarction manifested as acute ST-segment elevation who were treated with primary percutaneous intervention.
Methods: This study was case-control study of 60 cases, diagnosed with myocardial infarction manifested as acute ST-segment elevation going for primary percutaneous intervention and 30 healthy individuals as control group. Blood samples of both groups were taken on admission and analyzed for 25-hydroxy vitamins-D levels and serum electrolytes including calcium, magnesium, sodium, and potassium.

Results: There was statistically significant decrease in 25-hydroxy vitamin D level in cases compared with control group (p-value = 0.02), along with significant (p-value < 0.001) reduction in serum electrolytes in cases compared with control group.

Conclusions: Deficiency of vitamin-D may predispose to the development of ischemic heart disease, so screening for vitamin-D deficiency should be considered in patients with myocardial infarction.

Keywords: Acute STEMI, 25-hydroxy vitamin-D, PCI

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INTRODUCTION

Cardiovascular disease (CVD) is considered a major public health problem. About one-third of the mortality and 10% of morbidity was attributed to CVD, worldwide. According to the WHO, 2005, from 58 million deaths around the world, 17 million were attributed to CVD. Among them about 7.5 million casualties were attributed to coronary heart disease (CHD). Myocardial Infarction (MI) is considered as one of the five fundamental signs of CHD i.e. stable and unstable angina pectoris, MI, heart failure and sudden death [1].

Worldwide, acute myocardial infarction (AMI) was linked with increased morbidity and mortality rates in hospitalized patients and it is commonly known as "Heart Attack". It was recognized that AMI is more common in male patients compared to females. MI was defined as a state of necrosis of the myocardium when there is shortage of the coronary blood flow. This leads to damage in the myocardium thus increasing metabolic demand and decreasing oxygen and nutrients supply to the myocardium via the coronary flow. This followed a rapid coronary occlusion which was previously narrowed by atherosclerosis [2].

It was reported that several factors (vascular endothelial, smooth muscle and inflammatory cells) contributed to vascular homeostasis, formation, and stabilization of atherosclerotic lesions [3-5]. Also, it was recognized that vitamin-D receptors found within the nucleus of these cells might promote the integral mechanistic role of vitamin-D in the development and ischemic diseases progression [6-9].

Several previous researches reported consistent evidence of possible relationship between the level of vitamin-D and cardiovascular disease [10-14]. Previous animal and human studies suggested that vitamin-D could be arterial toxic. Moreover, consistent evidence claimed that there is an association between high intake of vitamin-D and increased IHD incidence [10].

The current study aimed to investigate the level of 25-hydroxy vitamin-D and serum electrolytes in myocardial infarction patients with acute ST-segment elevation (STIMI) treated with primary percutaneous intervention (PCI).

METHODS

This study was a case-control study where 90 participants (60 MI cases and 30 control) were recruited in the period from January 2019 to November 2019 in the cardiology department of Aswan University. G*Power 3 software was used for sample calculation. Using a power of 80% and α error of 5%, the minimum required sample was 60 respondents (30 MI patients and 30 control) to detect an effect size of 20% in the mean level of vitamin-D. To avoid possible losses of samples (dropouts) during the study, the number of patients was increased to 60 to be a total of 90 patients.

Ethical approved was obtained by the institutional review board (IRB) of the medical school, Aswan University and was in accordance with the guidelines of the declaration of Helsinki. A written informed consent was taken from the patients before the start of study.

Baseline data collection was executed via structured questionnaire of two sections: basic socio-demographics (i.e. name, age, sex, education status) and clinical data (risk

factors for IHD, acute chest pain onset time and illegibility for primary PCI).

The study subjects underwent laboratory investigations; blood samples were collected within 30 minutes of admission from anti-cubital vein with all aseptic precautions in supine position in plain containers for 25-hydroxy vitamin-D levels, serum electrolytes including calcium, magnesium, sodium and potassium, random blood sugar and hemoglobin AIC. Vitamin D (25[OH] D) levels were assessed by radioimmunoassay procedure.

Echocardiography was carried out on day of admission for both groups and images was obtained with left lateral decubitus using Philips Healthcare (Philips x matrix iE 33). Data attainment was conducted in parasternal and apical views using (X5-1) transducer. standard M-mode, 2D, and doppler blood flow measurements were performed. Left ventricular end-diastolic volume (LVEDV) and ejection fraction (EF) were analyzed by Simpson biplane method from apical imaging planes [11]. Volume of cardiac chamber were indexed to body surface area.

Statistical analysis

The collected data was verified, screened, and analyzed using IBM-SPSS software, version 21 (IBM SPSS Statistics for Windows, Version 21, Armonk, NY: IBM Corp, 2012). Descriptive statistics were interpreted as mean and standard deviation, frequency, and percentage. Independent t-test was conducted to compare the difference in the means for normally distributed continuous variables between cases and controls and statistical significance was considered when p-value < 0.05.

RESULTS

The current study was a case-control study that was executed in the period from January 2019 to November 2019 in the cardiology department of Aswan University. Participants were 60 STEMI cases and 30 healthy controls. Out of the 60 AMI cases, those with hypertension and diabetes represented about 27% and 42% respectively.. It was noticed that STEMI group had significantly higher age in comparison to the control healthy subjects (55.2 ± 9.6 vs. 32.6 ± 5.8 years; P< 0.001). The majority (82%) of the STEMI cases were males while the majority (56.7%) of the controls were females and this was significant (P < 0.001). Likewise, there was significant differences between both groups regarding the frequency of diabetes mellitus (20 (33.3%) vs. 3 (10%); P = 0.01), frequency of hypertension (24 (40%) vs. 5 (16.7%); P = 0.02) and smoking (27 (45%) vs. 6 (20%); P = 0.01) comparison to control (Table 1).

It was found that the STEMI group had significantly lower vitamin-D level than control group (201.7 ± 9.7 vs. 25.3 ± 10.7 mg/dl; P= 0.02) (Table 2). Furthermore, among STEMI group, there was a significant lower vitamin-D level in patients with reduced left ventricular ejection fraction (LVEF) than those with preserved LVEF, p-value < 0.001 (Table 3). Additionally, baseline serum electrolytes of the enrolled groups were shown in table 4. It was concluded that the STEMI group had significantly lower calcium (9.37 ± 0.4 vs. 10.36 ± 3.9 mg/dl; P= 0.04), sodium (137.84 ± 3.9 vs. 142.93 ± 2.3 µmol/l; P < 0.001), potassium (4.03 ± 0.5 vs. 4.33 ± 0.4; P < 0.001) and magnesium level (2.08 ± 0.2 vs. 2.40 ± 0.4) in comparison to control group; p-value = 0.01).

DISCUSSION

It was reported that several factors such as vascular endothelial, smooth muscle and inflammatory cells contribute to the vascular homeostasis, formation, and stabilization of atherosclerotic lesions [3-5]. Also, it was recognized that vitamin-D receptors found within the nucleus of these cells might promote the integral mechanistic role of vitamin-D in the development and progress of ischemic diseases [6-9]. Therefore, in this study the primary aim was to study the level of 25 hydroxy vitamin D in patients with STEMI managed by primary percutaneous intervention (PCI) to detect any association between vitamin D level and MI.

In the current study, it was found that in the STEMI group a significant increase in the percentage of DM, hypertension and smoking than control group and there was higher age in the STEMI group than control, as well established these factors considered as a risk factors for IHD.

Also, in this study there was a statically significant correlation between Vitamin D deficiency and the presence of IHD. This was in agreement with Lee JH et al 2008 study that divided the 2910 patients with CAD history (acute myocardial infarction either stable or unstable angina) into three groups based on their angiography results. The study concluded that although vitamin-D deficiency was equally prevalent in all groups, this prevalence was more evident in cases of stable angina and also it was one of the predictors of poor prognosis i.e. death, MI, cerebral stroke, or the need to revascularization [10].

Numerous studies have found strong relationship between vitamin-D deficiency and HF progression [12, 13]. Previous studies found that HF patients mostly had vitamin-D deficiency, and this was significantly associated with poor prognosis. Moreover, it was observed that provision of supplement of vitamin-D for HF cases could reduce the mortality rate [13]. Previous studies reported that vitamin-D plays a major role as a negative regulator of the renin–angiotensin–aldosterone system (RAAS) and modulates myocardial extracellular matrix turnover [14]. Consistently, vitamin-D receptor knockout mice showed increased RAAS activity, which leads to hypertension, cardiac hypertrophy, increased water intake and sodium retention, and also, increased metalloproteinase activity, which promotes the destruction of myocardial tissue, leading to ventricular remodeling [15,16].

Therefore, vitamin-D deficiency could lead to deterioration of heart function and acceleration of myocardial remodeling. This was consistent with the findings of this study that reported significant positive correlation between vitamin D reduction and impairment of LV systolic function.

In this research, it was reported that the AMI group had significantly lower levels of calcium, sodium, and potassium compared with controls. These results was in line with the findings of Hariprasad S. and Basavaraj M. 2018, who concluded that the serum sodium levels was significantly lower among AMI cases in both ages compared to healthy

controls but also there was decrease in potassium which is against our result regarding level of potassium [17].

Also, our result was in line with Vamne A et al, who found that AMI cases had higher rates of hyponatremia compared with control. It was reported that the decrease in the sodium level might be caused by hypoxia and ischemia, thus increase the sarcolemma sodium permeability. Nevertheless, no significant difference in the serum potassium level between control and case could be detected [18].

Additionally, AMI patients were found to have hyponatremia which could be attributed to the fact that non-osmotic secretion of vasopressin impairs the water secretion causing dilutional hyponatremia. AVP or vasopressin is known to regulate tone and cardiac contraction and may adversely affect cardiac hemodynamics and myocardial remodeling. It was proposed that hyponatremia on admission or early development of hyponatremia in STIMI patients was an independent predictor of mortality. Correspondingly, there was a strong association between the poor prognosis and the hyponatremia severity [19].

In this study there was also decrease in the magnesium level in the AMI group versus healthy control group and this was in accordance with the results of Kughapriya, P. et al., 2016, which concluded that there was a decrease in the magnesium level in patient with IHD compared to the control group [20]. It was found that magnesium had essential role in the mechanism of cardiovascular homeostasis. Several mechanisms have been proposed for the magnesium role in the pathogenesis of IHD. Hypomagnesaemia could also be the result of serious ischemia [21].

CONCLUSION

Routine screening for vitamin-D deficiency in patients with acute STEMI was advised as it is considered as one of the risk factors for developing of IHD.

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DISCLOSURE

There were no conflicts of interest in this work.

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TABLE LEGEND

Table 1: Baseline data among enrolled groups

	STEMI group (n= 60)	Control group (n= 30)	P value
Age (years)	55.23 ± 9.56	32.60 ± 5.78	< 0.001
Sex			
Male	49 (81.7%)	13 (43.3%)	< 0.001
Female	11 (18.3%)	17 (56.7%)	
Diabetes mellitus	20 (33.3%)	3 (10%)	= 0.01
Hypertension	24 (40%)	5 (16.7%)	= 0.02
Smoking	27 (45%)	6 (20%)	= 0.01

Data expressed as frequency (percentage), mean (SD). P value was significant if < 0.05, STEMI= ST segment elevated myocardial infarction.

Table 2: Serum vitamin D among enrolled groups

	STEMI group (n= 60)	Control group (n= 30)	P value
Vitamin D (ng/dl)	20.17 ± 9.71	25.33 ± 10.67	= 0.02

Data expressed as frequency (percentage), mean (SD). P value was significant if < 0.05, STEMI= ST segment elevated myocardial infarction.

Table 3: relation of vitamin D & LV EF among Patients of STEMI group.

	Cardiac function		P value
	Impaired (n= 38)	Preserved (n= 22)	
Vitamin D (ng/dl)	17.64 ± 9.35	24.54 ± 8.91	< 0.001

Data expressed as frequency (percentage), mean (SD). P value was significant if < 0.05

Table 4: Serum electrolytes and vitamin D among enrolled groups.

	Study group (n= 60)	Control group (n= 30)	P value
Calcium (mg/dl)	9.37 ± 0.38	10.36 ± 3.91	= 0.04
Magnesium (mEq/l)	2.08 ± 0.17	2.4 ± 0.35	= 0.01
Phosphorus (mg/dl)	3.44 ± 0.97	3.49 ± 0.61	= 0.76
Sodium (µmol/l)	137.84 ± 3.86	142.93 ± 2.27	< 0.001
Potassium (mg/dl)	4.03 ± 0.52	4.33 ± 0.44	< 0.001

Data expressed as frequency (percentage), mean (SD). P value was significant if < 0.05

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