Journal of Cardiovascular Disease Research

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 04, 2023

ORIGINAL RESEARCH

Serum phosphate levels and carotid intimal-medial thickness in people with chronic renal disease- A comparative study

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Received: 14 February, 2023 Accepted: 20 March, 2023

Abstract

Background: A side effect of advanced chronic kidney failure is hyperphosphatemia(CKD). An important risk factor for vascular calcification, an advanced type of atherosclerosis, is an elevated serum phosphate concentration. The increased vascular stiffness brought on by the medial deposition of calcium and phosphorus also contributes to the high incidence of hypertension. In individuals with CKD, carotid ultrasound imaging is a helpful adjunct for measuring arterial wall thickness. Goal: To evaluate the relationship between carotid intimal-medial thickness and blood phosphate with CKD.

Materials and Methods: The Department of Medicine and the Department of Radiology and Imaging both participated in this research. In this research, all CKD patients with stage III to stage V between the ages of 30 and 60 who visited the outpatient and inpatient departments were included. Patients were diagnosed using their medical history, physical exams, and pertinent tests. Using the Revised Schwartz method, the glomerular filtration rate (GFR) was determined from serum creatinine. Every participant experienced carotid intimal-medial thickness (CIMT) measurement using a 7.5MHz transducer and B mode ultrasonography (Philips, Affiniti 30; USA).

Results: 50 individuals in total were examined. (35 male, 15 female). The progression of the illness was accompanied by a marked rise in the mean phosphorous level. The mean CIMT rises along with the progression of CKD. As the stage of CKD increases the mean CIMT also increases. mCIMT in Stage III was 0.40±0.02mm and that of Stage IV, Stage V(ND) and VD were 0.45±0.05mm, 0.60±0.08mm, and 0.55±0.06mm respectively.In addition to other independent risk variables, such as serum calcium and serum PTH, serum phosphate was also a significant (p=0.0001) independent risk factor for increased CIMT.

Conclusion: Greater CIMT with advanced CKD was significantly and independently correlated with higher serum phosphate levels.

Keywords: Carotid intimal-medial thickness, chronic kidney disease, phosphate.

Introduction

Chronic kidney disease (CKD) have an increased risk of developing cardiovascular disease, which is the leading cause of morbidity and mortality in this patient population. Chronic kidney disease (CKD) is a condition that worsens over time and is usually irreversible[1].

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 04, 2023

According to some estimates, the mortality rates associated with cardiovascular disease in adults who contracted the end-stage renal disease during childhood are 1,000 times higher than the mortality rates associated with cardiovascular disease in individuals of comparable age who are healthy[2]. The progression of renal dysfunction is linked to a number of biochemical and hemodynamic abnormalities that have a significant impact on the cardiovascular system. However, serum phosphate levels are often maintained within the normal laboratory range until relatively late in the course of CKD. This is because phosphate retention, elevated parathyroid hormone (PTH) levels and low 1,25-dihydroxy vitamin D levels are all caused by a decrease in renal function[3].

Therefore, in people who had a normal renal function, serum phosphate was found to have a positive association with the carotid intimal-medial thickness (CIMT), and even with mortality [4]. This was the case despite the fact that conventional cardiovascular risk factors were not present. Calcification of the blood vessels is the primary mechanism that is implicated in the pathophysiology of phosphate-induced cardiovascular risk. On the other hand, elevated phosphate levels have been linked to endothelial dysfunction, which can boost the likelihood of developing atherosclerosis and hypertension. An abnormality in the structural makeup of the blood vessels, as determined by the determination of an increased carotid intimal medial thickness using ultrasound. It has been observed that patients with CKD have a high prevalence of dyslipidemia as well as subclinical vascular damage, which is demonstrated by an increase in CIMT[5].

Therefore, the purpose of this research was to determine whether or not effective steps can be taken to prevent hyperphosphatemia-induced morbidity in those who have chronic kidney disease by analyzing the correlation between serum phosphate levels and carotid intimal-medial thickness in this population.

Materials and Methods

In a correlative study conducted by the Departments of Medicine and Radiology and Imaging, patients with stage III-V chronic kidney disease (CKD), regardless of the primary cause and between the ages of 30 and 60 of both sexes, admitted as inpatients or attending outpatient clinics were included. Patients with known family histories of dyslipidemia and any congenital heart disease were excluded from the research. The diagnosis of CKD was made based on the patient's medical history, physical evaluation, and some laboratory tests, including those for calcium, inorganic PO4, electrolytes, and creatinine. (iPTH). Dietary recall from the preceding three days was used to glean information about phosphate-containing diet history. Each patient was divided into various CKD stages after the eGFR was measured.

Carotid artery intimal-medial width measurements 7.5MHz transducer B mode ultrasonography (Philips, Affiniti 30; USA) was used to quantify the carotid intimal medial thickness. The distance between the leading margin of the first echogenic line (Lumen-Intima interface) and the second echogenic line (Media-Adventitia interface) of the far wall is known as the intimal-medial thickness. On each side, three measurements were made at intervals of 0.5, 1, and 2 centimeters below the common carotid arteries bifurcation. These were then averaged mathematically.

The mean and standard variations were computed for various parameters. Values of P that were considered significant (0.05) were those. The statistical study was carried out using SPSS version 22. Data on the continuous variables were presented as Mean ± SD. Continuous variables were compared through ANOVA test. Pearson correlation test was done to assess the relationship between CIMT and serum phosphate and other clinical variables. Multiple linear regression analysis was used to analyze the effect of several parameters on CIMT.

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Results

In this study, out of 50 patients, Among them 35 were male and 15 were female [Table 1].

Table 1: Demographic data of subjects (n = 50)

Frequency (n) Percentage(%)

Age (years)		
Mean±SD	**15.41±3.55**	
Gender		
Male	35	70%
Female	15	30%
Causes of CKD		
Hypoplastic Kidney	19	38%
Glomerulonephritis	15	30%
Obstructiveuropathy	9	18%
Others	7	14%

As the stage of CKD increases the mCIMT increases. In our study mCIMT in Stage III was 0.40±0.02mm and that of Stage IV, Stage V(ND) and VD were 0.45±0.05mm, 0.60±0.08mm and 0.55±0.06mm respectively [Table 2].

Table 2: Intimal- medial thickness level in CKD

StagesofCKD	**Intimalmedialthickness(mm)**	**p-value**
	Mean±SD	
StageIII	0.40±0.02	0.001
StageIV	0.45±0.05	
StageV(ND)	0.60±0.08	
StageV(D)	0.55±0.06	

To examine the combined effect of factors affecting CIMT, multiple linear regression analysis was performed [Table 3]. Here serum inorganic phosphate was a significant (P = 0.001) independent factor for increased CIMT.

Table 3: Multiple linear regression analysis of factors associated with CIMT

Variable	**B**	**Std.Error**	**Ƀ**	**P Value**
SystolicBloodPressure(mm Hg)	.000	.000	.055	.550
DiastolicBloodPressure(m mHg)	.001	.000	.245	.289
BMI(kg/m^2)	-0.002	.002	-0.045	.661
Seruminorganicphosphate(mg/dl)	.040	.006	.654	0.001
Serumcalcium(mg/dl)	.024	.010	.245	.010
SerumPTH(pmol/L)	.000	.000	.350	.006
Totalcholesterol(mg/dl)	.000	.000	-.105	.301
HDL(mg/dl)	.002	.002	.186	.065
LDL(mg/dl)	-.00025	.000	.012	.935
Triglyceride(mg/dl)	.001	.000	.164	.101

Discussion

This research was conducted on a total of fifty CKD patients ranging in age from 30-60 years old. There were a total of 50 people, with 35 being male and 15 being female. As this is

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 04, 2023

a tertiary care facility, the majority of patients who presented with us had advanced stages of chronic kidney disease (CKD). One of the most striking aspects of the current research is that more than half (65%) of who participated in the study have stage V CKD.

When compared to stages III, IV, and V(D), the level of inorganic phosphate in stage V(ND) CKD was significantly higher than that of stages III, IV, and V(D) CKD. It is conceivable that regular dialysis was the cause of comparably lower serum inorganic phosphate levels in stage V(D) CKD. In patients with CKD, hyperphosphatemia has been found to be a significant risk factor for the development of secondary hyperparathyroidism and uremic bone disease. Reduction of phosphate level through the use of phosphate binders has been reported to attenuate vascular calcification[6]. In addition, hyperphosphatemia has been found to be a significant risk factor for the development of vascular complications[7].

Dyslipidemia is a frequent complication of progressive kidney disease as well as an independent risk factor of cardiovascular disease. It is distinguished by high levels of total cholesterol and triglycerides and low levels of high-density lipoprotein (HDL) cholesterol. In some studies, patients had significant hypertriglyceridemia, increased LDL, and low HDL level, and these were significantly associated with increased CIMT[8]. However, in the current study, we found that there was no significant association between lipid profile and CIMT. The carotid intima-media thickness (CIMT), which can be measured using noninvasive ultrasonography, has been described to be an early marker of atherosclerosis and a predictor of vascular events.

It has been shown that exposure to inorganic phosphate can cause vascular smooth muscle cells to take on the phenotype of osteoblast-like cells [9]. This change can also be caused by exposure to core-binding factor a 1, which is an essential transcription factor in the process of osteoblastic differentiation in vascular smooth cells. According to these findings, hyperphosphatemia may trigger osteoblastic phenotypic changes in vascular smooth muscle cells as well as vascular cell proliferation, both of which contribute to increased arterial wall thickness in patients with chronic kidney disease (CKD). Another of the most prevalent complications of CKD is high blood pressure. CIMT was found to have a significant positive correlation with both systolic and diastolic blood pressure in a number of studies [10]. However, the current research did not find any significant association between blood pressure and CIMT. This could be because the majority of the people who participated in the research were already receiving treatment for hypertension.

According to the findings of the current research, an elevated serum phosphate level is a substantial and independent risk factor for increased CIMT. This is in addition to other independent risk factors, such as an elevated serum calcium level and an elevated serum PTH level. The results of other research back up the validity of this hypothesis[11].The serum phosphate level should be screened for and monitored on a regular basis in those who have CKD because it has the potential to be an indicator of increased CIMT.

The current research had a few flaws and restrictions. First, there was a limited number of people included in the sample, and second, the research was conducted at a specific location. For this reason, further research involving multiple centers and larger populations may be required to substantiate these conclusions.

Conclusion

In patients with advanced stages of chronic kidney disease (CKD), a significant and independent factor correlated with increased CIMT was a higher serum phosphate level. It is essential for CKD patients to achieve optimal management of their hyperphosphatemia through the use of the appropriate intervention in order to forestall future morbidities and mortalities.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 04, 2023

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