Relation of calcium phosphorus product with cardiovascular risk and hscrp in hemodialysis patients

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Abstract: Objective: In extensive studies done on chronic kidney disease (CKD) patients, dysregulated bone mineral metabolism is closely associated with the risk of cardiovascular disease and increased risk of morbidity and mortality is revealed. In this study we examine the relationship between calcium phosphorus product which is known to be an independent risk factor in chronic hemodialysis patients and HsCRP values.

Materials-methods: Patients were grouped into two according to presence of ischemic heart disease. In addition, in subgroup analysis of our study, all groups were divided into two according to CaxP levels being under 55 (< 55) (Group A) and over 55 (≥ 55) (Group B) and again compared in terms of independent ischemic heart disease.

Results: A positive correlation was found between CaxP and HsCRP in hemodialysis patients ($p < 0.001$). The correlation between CaxP and HsCRP was statistically more significant in ischemic heart disease (IHD) patients compared to non diseased patients ($p < 0.001$; $p < 0.02$). In the analysis of the subgroup study, it is found that hsCRP values were statistically higher in group A compared to group B ($p < 0.001$).

Conclusion: In our study, we found a significant relationship between CaxP and HsCRP in chronic hemodialysis patients. Also we think that in chronic hemodialysis patients with target CaxP values (CaxP <55 mg/dl), IHD prevalence is low and keeping CaxP <55 with treatment would effect cardiovascular mortality.

Keywords: Calcium phosphorus, HsCRP, cardiovascular risk

INTRODUCTION

The most important cause of mortality in patients with end-stage renal disease (ESRD) is atherosclerotic vascular complications [1,2]. Bone mineral metabolism is dysregulated in chronic kidney disease (CKD) patients starting from the early stages [3]. In extensive studies done on this population it is determined that dysregulated bone mineral metabolism is closely associated with increased risk of hip fracture, cardiovascular disease and increased morbidity and mortality risk [4-7]. In end-stage renal disease (ESRD) patients, bone mineral densitometry was determined significantly lower than normal population and it is detected that in these patients as the duration of dialysis increases reduction of bone mineral density in densitometer becomes more evident [8].

In recent clinical and experimental studies it is shown that quite similar mechanisms take role with calcification of vascular wall and bone mineral metabolism. In addition to this, an independent relationship between vascular calcification and bone metabolism was found [9-10]. There are publications stating the potential risk factors such as recently described homocystein, C-reactive protein (CRP), interleukin (IL)-6, fibrinogen, soluble intracellular adhesion molecule-1, asymmetric dimethyl arginine, advanced glycation products contributing to accelerated atherosclerosis seen in ESRD patients [11, 12, 13]. In this study, we searched the relation between calcium phosphorus product which is known to be an independent risk factor in chronic hemodialysis patients and HsCRP which is used as a risk marker for cardiovascular diseases.

MATERIAL AND METHODS

Our study was cross-sectional retrospective in nature, done by retrospective analysis of files of 91 hemodialysis patients in a private dialysis Center in Istanbul in May 2013 and May 2014. 91 patients who received at least 6 months of regular dialysis, not having any infective and/or inflammatory disease were included in the study. Patients with wbc > 10,000, plt > 400,000, HIV and HbsAg positivity, malignancy, cachexia, who had gastrointestinal bleeding, and hospitalized for any reason were excluded from the study. Besides the demographic features such as age, gender, primary disease, ischemic heart disease, peripheral vascular disease; levels of kt/v, calcium, phosphorus, calcium x phosphorus, hsCRP, PTH, WBC, PLT, albumin were obtained retrospectively from the file data of all cases. Patients were grouped into two as having ischemic heart disease or not (patients who had wall movement dysfunction in ecocardiography, positive myocardial perfusion scintigraphy, pathologic Q detected on ECG, stent, CABG surgery were included in the ischemic heart disease group.)

In addition, in subgroup analysis of our study, all groups were divided into two according to CaxP levels <55 and ≥ 55 .

STATISTICAL ANALYSIS

While in the analysis of data with normal distribution student t-test, pearson correlation analysis, linear regression analysis were used, of data with non-normal distribution Mann Whitney U test, spearman correlation test were used. In single analysis the variables with p value < 0.25 were processed with multiple regression analysis. In categorical variables χ^2 test was used. The data were assessed in SPSS statistical program. Significance level was considered to be $p < 0.05$.

RESULTS

The average age of the patients was 63.96 ± 13.34 . When we looked at the gender distribution it was 52.7% women, 47.3% male. The patients were hemodialysis patients of end stage renal disease with backgrounds of 4 (4.4%) amyloidosis, 39 (42.9%) diabetes, 22 (24.2%) hypertension, 15 (16.5%), idiopathic, 1 (1.1%) neurogenic bladder, 2 (2.2%) pyelonephritis, 6 (6.6%) polycystic kidney, 1 (1.1%), toxic nephropathy, 1 (1.1%) vesicoureteral reflux. Of the patients 29 (31.9%) had ischemic heart disease, 8% (8.8) percent had peripheral vascular disease. 60 patients had neither ischemic heart disease or peripheral vascular disease; 29 patients just had

ischemic heart disease, 39 patients with diabetes had been identified. In all patients with ischemic heart disease diabetes accompanied except for 3 cases, diabetics with undetermined IHD were excluded due to the probability of undiagnosed ischemic heart disease presence (**Table 1**).

A positive correlation between HsCRP and CaxP was observed (Figure 1, $p < 0.001$). The correlation between CaxP and HsCRP was higher in patients with IHD compared to patients without IHD (Figure 2, $p < 0.001$; $p < 0.02$). HsCRP values in Group A and Group B patients were compared (Figure 3). Along with positive correlation of CaxP product between both groups, it is determined that hsCRP values of patients with $\text{CaxP} \geq 55$ (Group A) had statistically more significance than values of Group B ($p < 0.001$).

In IHD group kt/v ratio, calcium value, phosphorus value, CaxP value, HsCRP value were found to be higher ($p < 0.05$). PTH, wbc, plt and albumin values were similar in both groups ($p > 0.05$) (**Table 2**).

With comparison of A and B groups according to the biochemical values, these results were obtained: kt/v value, wbc, PLT and albumin values were similar in both groups, there was no significant difference ($p > 0.05$). Calcium, phosphorus, CaxP, HsCRP and PTH values were found statistically higher in group A ($p < 0.05$). Prevalence ratio of IHD and PVD was higher in group A than group B ($p < 0.001$) (**Table 3**).

DISCUSSION

Calcium-phosphorus metabolism alterations starting in the early stages of renal insufficiency negatively affects the cardiovascular system [14,15]. Atherosclerosis and coronary artery disease associated with chronic inflammation are the most important risk factors responsible for mortality and morbidity of end-stage kidney disease. High levels of calcium x phosphorus ($\text{CaxP} \geq 55\text{mg/dl}$) were thought to increase vascular calcification inflammation is thought to play an important role in atherosclerosis. CRP as an inflammation marker is intensely related with increased cardiovascular morbidity and mortality (16,17). In this study we aimed to present the relation of calcium phosphorus product in and HsCRP with each other and with cardiovascular risk in hemodialysis patients. In our study positive relationship between hsCRP and CaxP was observed in chronic hemodialysis patients relationship between hsCRP and CaxP was higher in hemodialysis patients with ischemic heart disease compared to patients without ischemic heart disease. Given the KDOQI clinical

practice guideline the aim was to keep CaXP < 55mg/dl [18]. We found hsCRP lower in patients with CaxP < 55 compared to patients with CaxP ≥ 55 mg/dl. In the study Ezio Movilli et al did [19], a positive correlation between hsCRP CaxP has been identified were detected higher. HsCRP levels were significantly lower in patients with CaxP < 55. In study of Chien-Te, Lee et al [20] direct proportion has been identified between hsCRP levels and serum Ca, P, CaxP levels in accordance with our work; hsCRP value is lower also in patients who reached to the treatment goal (CaxP <55 mg/dl) compared to patients who did not reached to the treatment goal. In the study of H. Nasri et al [21] positive correlation has been revealed between serum hsCRP logarithm and CaxP in accordance with our study. In another study of Navarro-Gonzalez JF and his friends similar results have been obtained as with ours. In this study, positive relationship between hsCRP and P, CaxP has been found [22]. It is known that the calcification is more important than plasma cholesterol levels in development of atherosclerosis in hemodialysis patients. When we looked at the study of 4 D about dialysis patients it was observed that as plasma LDL cholesterol levels were decreased under 75 mg/dl with 10 mg/day atorvastatin, morbidity and mortality rates related with ischemic heart disease did not decreased [23]. SHARP study which also includes peritoneal dialysis patients shows reduction of the plasma cholesterol levels does not decrease cardiovascular events in ESRD patients [24]. Similar results are seen in the AURORA study [25]. Calcium, phosphorus, and calcium phosphorus product are high in hemodialysis patients with chronic renal failure;

increase in intima calcification is seen when the pathophysiology of atherosclerosis depend on this is considered [26]. Depending on increased vascular rigidity due to calcification cardiac output in perfusion and blood pressure plays a critical role [27] as a result of narrowing of the vascular lumen. This is why low blood pressure is capable of causing ischemia and threaten patients (for example depending on the fluid removal after dialysis). Frequently seen sudden cardiac deaths (28) in dialysis patients can be explained with this. By contrast, acute myocardial infarction occurring with rupture of lipid and cholesterol-rich plaques in dialysis patients is relatively rare. In 4 D study with up to four-year follow-up period of [23], while myocardial infarction constitutes only 22 percent of cardiac death, sudden cardiac death constitutes 55 percent of deaths. In a recent study of incident dialysis patients within 5 years, as cardiovascular event

while only 6-8,1 percent had non-fatal myocardial infarction, arrhythmia, heart failure, pericarditis, myocarditis, pulmonary edema or heart death related to the arrest was seen 5 to 7 times more frequently [29]. As a result, plasma cholesterol levels play a minor role in changed atherosclerosis in dialysis patients and this situation explains the before mentioned statin treatment not being effective in dialysis patients. This transformation occurs on which phase of chronic kidney disease and depending on which factors is not yet known. Results of many large-scale randomized, prospective studies suggests that basal hsCRP values may have an important place in determining cardiovascular risk [30-41]. These studies include numerous young/elderly, female/male patients from diverse races. Besides cardiovascular death and myocardial infarction determination, hsCRP is also useful in prognosis of stroke, sudden death and peripheral vascular disease development ; hence, CRP is an important determinant of global vascular risk (35.36, 39). When it is considered that the high hsCRP determines future cardiovascular event risk and reducing its levels may be protective, strategies that may affect hsCRP levels gain importance.

Our study was designed as a retrospective and cross-sectional study, though reaching to bigger numbers of IHD patients was aimed during the planning phase of our study, a small number of IHD patients was collected, and this prevents the universalization of results despite the existence of a positive correlation in accordance with the literature in our statistical analysis.

In our study, we found a significant relation between CaxP and HsCRP in hemodialysis patients. It is known that the increase of CaxP product plays a role in vascular calcification and this constitutes a risk for cardiovascular diseases [26]; HsCRP is used as a marker for cardiovascular risk and in the study we have done we found a significant relation between these two parameters. While cardiovascular diseases being the most important mortality reason in chronic hemodialysis patients, as seen in our study, in chronic hemodialysis patients with target CaxP values (CaxP<55 mg/dl), IHD rates are lower, by contrast, patients with CaxP $\geq$ 55 IHD rates are higher and yet in this group hsCRP levels which is a positive marker were detected higher. Therefore with keeping CaxP < 55, we think that IHD and HsCRP would decrease and have an impact on mortality.

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Table 1. General features of the patients

Feature	(N = 91) AVG. $\pm$ std,%, median
Age	63.96 $\pm$ 13.34
Gender	
Male	43 (47.3 %)
Female	48 (52.7%)
Primary disease	
Amyloidosis	4 (4.4%)
Diabetes	39 (42.9%)
Hypertension	22 (24.2%)
Idiopathic	15 (16.5%)
Neurogenic bladder	1 (1.1%)
Pyelonephritis	2 (2.2%)
Polycystic kidney	6 (6.6%)
Toxic nephropathy	1 (1.1%)
Vesicoureteral reflux	1 (1.1%)
Kt/v	1.52 $\pm$ 0.17
Calcium	8.88 $\pm$ 0.68
Phosphorus	4.95 $\pm$ 1.31
It is known that	44.08 $\pm$ 12.46
HsCRP	2.2
PTH	360
WBC	6.79 $\pm$ 1.49
PLT	206.21 $\pm$ 70.66
Albumin	3.8
Ischemic heart disease	
Present	29 (31.9%)
Absent	62 (68.1%)
Peripheral vascular disease	
Present	8 (8.8%)
Absent	83 (91.2%)

Table 2. Comparison of biochemical parameters of patients with and without Ischemic Heart Disease

Parameter	IHD present Avg±std or median	IHD absent Avg±std or median	P value
Kt/v	1.49±0.17	1.59 ± 0.17	0.005
Calcium	9.12±0.62	8.76±0.68	0.015
Phosphorus	5.57 ± 1.55	4.62±1.04	0.004
It is known that	50.86±14.52	40.57 ± 9.64	0.001
HsCRP*	3	2	0.002
PTH*	373	344	0321
WBC	6.83 ± 1.58	6.72 ± 1.31	0.754
PLT	210±76.07	198.87±59.25	0.479
Albumin*	3.8	3.8	0.399

Table 3. Comparison of biochemical parameters of patients who were separated into two groups according to the CaxP cut-off point

Parameter	Group A (CaxP $\geq$ 55) n=59 Avg $\pm$ std, median, n and %	Group B (CaxP < 55) n = 32 Avg $\pm$ std, median, n and %	P value
Kt/v	1.58 $\pm$ 0.17	1.51 $\pm$ 0.17	0.179
Calcium	9.24 $\pm$ 0.39	8.81 $\pm$ 0.70	0.002
Phosphorus	6.88 $\pm$ 0.87	4.56 $\pm$ 1.01	0.001
It is known that	63.59 $\pm$ 7.86	40.22 $\pm$ 9.14	0.001
HsCRP	6.96 $\pm$ 2.76	2.00 $\pm$ 0.96	0.001
PTH*	521	329	0.049
WBC	6.80 $\pm$ 1.53	6.72 $\pm$ 1.28	0.834
PLT	208.99 $\pm$ 73.97	192.13 $\pm$ 50.28	0.402
Albumin*	3.8	3.8	0.825
IHD n (%) †	23/59 (38)	10/32 (32.2)	0.001
PVD n (%) †	7/59 (9.1)	1/32 (6.7)	0.001

***Mann Whitney U test, † Fisher Exact test, student t test**

Figure 1.CaxP and HsCRP relationship in hemodialysis patients

Figure 2. CaxP and HsCRP relation in hemodialysis patients with and without ischemic heart disease

Group A	Group B
CaxP $\geq$ 55, n = 59	CaxP < 55, n = 32

Figure 3.Relationship between CaxP and HsCRP according to the cut-off value of 55mg/dl in hemodialysis patients