

Correlation of Serum Calcium, Phosphorous, Parathyroid Hormone, and Calcium × Phosphorous Product in CKD Patients on Hemodialysis

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Abstract

Introduction: Chronic kidney disease (CKD) is characterized by progressive decline in glomerular filtration rate with prevalence about 17% in India. Hyperphosphatemia induces hypocalcemia leading to hyperparathyroidism with incidence of about 50% in CKD patients on hemodialysis. The derangements in Sr. calcium and phosphorous levels and raised Calcium × Phosphorous (Ca × P) product accelerate vascular calcification and increase stiffness of pulmonary vasculature that increases cardiovascular events and mortality in CKD patients on hemodialysis. In this context, we aimed to evaluate the correlation between serum parathyroid hormone (PTH) and Ca × P product in CKD patients on hemodialysis.

Objectives: The aim of the study was to estimate Sr. PTH, calcium, and phosphorous levels in CKD patients on hemodialysis and calculate Sr. Ca × P product and to compare these parameters with apparently healthy controls.

Materials and Methods: This study was done at Gandhi Hospital, Secunderabad, Telangana, from August 2019 to January 2020, which included 50 CKD patients on hemodialysis aged between 35 and 70 years and 50 age and sex matched apparently healthy controls. Data were collected from clinical biochemistry laboratory.

Results: Sr. PTH (268.80 ± 68.30 pg/ml), sr. phosphorous (7.41 ± 0.77 mg/dl), and Ca × P product (53.84 ± 9.49 mg²/dl²) were significantly increased ($P < 0.001$) and sr. calcium (7.27 ± 0.99 mg/dl) was significantly decreased ($P < 0.001$) in cases compared to controls (27.7 ± 9.57 pg/ml, 3.2 ± 0.49 mg/dl, 32.5 ± 5.29 mg²/dl², 10.1 ± 0.59 mg/dl respectively). Sr. PTH shown negative correlation with Sr. calcium, positive correlation with Sr. phosphorous, and Ca × P product levels.

Conclusion: Increased serum PTH and calcium × phosphorous product levels in CKD patients on hemodialysis, put them into risk of developing vascular calcification and pulmonary hypertension leading to increase cardiovascular morbidity. Therefore, all CKD patients on hemodialysis need to be screened regularly for Sr. PTH and Ca × P product that helps to decrease the cardiovascular events and mortality in these patients.

Key words: Chronic kidney disease, Parathyroid hormone, Ca × P product, Vascular Calcification

INTRODUCTION

Chronic kidney disease (CKD) is associated with an irreversible damage in kidney functioning and progressive decline in glomerular filtration rate (GFR) and CKD is defined when GFR < 60 ml/min/1.73 m² for 3 months and

CKD prevalence in India is up to 17%.^[1-3] Serum parathyroid hormone (PTH) levels starts increasing typically when the GFR drops to < 60 ml/min/1.73 m². Serum PTH levels in the initial stages increase renal phosphorus excretion but further decline in GFR leads to hyperphosphatemia and induce hypocalcemia by binding bioavailable calcium as calcium phosphate. This indirectly leads to a further rise in PTH production to maintain calcium and phosphorous homeostasis, resulting in hyperparathyroidism and the prevalence of hyperparathyroidism is about 50% in CKD patients on hemodialysis.^[4,5]

The derangements in serum calcium and phosphorous levels and raised Calcium × Phosphorous (Ca × P) product

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accelerate vascular calcification of coronary artery and cardiovascular tissue and increase stiffness of pulmonary vasculature that leads to development of pulmonary hypertension and all these increase cardiovascular events and mortality in CKD patients on hemodialysis.^[4,6,7] In this context, we have undertaken this study to evaluate the correlation between Serum PTH and Ca × P product levels in CKD patients on hemodialysis.

Aim

- The aim of the study was to study the correlation of serum parathyroid hormone, calcium, phosphorous, and Ca × P product in CKD patients on hemodialysis.

Objectives

The objectives of the study are as follows:

1. To estimate Serum PTH, Calcium and Phosphorous levels in CKD patients on hemodialysis
2. To calculate serum calcium × phosphorous product
3. To compare these parameters with apparently healthy controls to assess the correlation of these parameters in CKD patients on hemodialysis.

MATERIALS AND METHODS

This was a retrospective case–control study done from August 2019 to January 2020 in Biochemistry department, Gandhi Hospital, Secunderabad, Telangana, India. The sample size was 100 that included 50 CKD patients on hemodialysis aged between 35 and 70 years as cases and 50 age and sex matched apparently healthy individuals as controls. Data collected from test results available in the Clinical Biochemistry laboratory based on inclusion and exclusion criteria. Serum PTH was estimated by chemiluminescence method in Siemens advita centaur XP machine, serum calcium and phosphorous were estimated by spectrophotometric method in Beckman coulter 5800 machine.

Inclusion Criteria

- Fifty clinically diagnosed CKD patients on hemodialysis aged between 35 and 70 years were included in the study.

Exclusion Criteria

- Patients with parathyroidectomy, thyroidectomy, and low serum albumin were excluded from the study.

Statistical Analysis

All continuous variables were presented in Mean ± SD. Student’s t-test and Pearson correlation were applied and P value < 0.05 was considered statistically significant

RESULTS

The mean age of CKD cases was 47.22 ± 9.62 years and of controls was 46.02 ± 10.37 years with no significant difference among them. There were 45 males and 55 females included in this study. The Mean ± values of biochemical parameters are given in Table 1.

Serum PTH ($P < 0.0001$), serum phosphorous ($P < 0.001$), and serum calcium × phosphorous product ($P < 0.0001$) levels were significantly increased in CKD cases compared to healthy controls. Serum calcium levels were significantly decreased ($P < 0.001$) in cases compared to controls.

As shown in the Chart 1, Sr. PTH levels were significantly increased in cases as compared to controls.

As shown in the Chart 2, sr. calcium levels were significantly decreased in cases as compared to controls.

As shown in the Chart 3, Sr. phosphorous levels were significantly increased in cases as compared to controls.

Ca × P product levels were significantly increased in cases as compared to controls as shown in Chart 4.

There was negative correlation of Sr. PTH with Sr. calcium as shown in Chart 5.

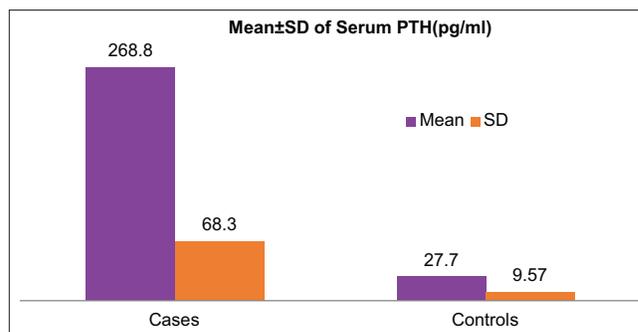


Chart 1: Comparison of serum PTH levels between CKD cases and controls

Table 1: Mean±standard deviation values of biochemical parameters in chronic kidney disease cases and controls

| Mean±SD | Cases | Controls | P |
|--|--------------|------------|---------|
| Blood urea (mg/dl) | 175.82±26.08 | 18.32±5.85 | <0.0001 |
| Serum creatinine (mg/dl) | 7.88±0.96 | 0.94±0.18 | <0.0001 |
| Serum PTH (pg/ml) | 268.80±68.30 | 27.7±9.57 | <0.0001 |
| Serum calcium (mg/dl) | 7.27±0.99 | 10.1±0.59 | <0.001 |
| Serum phosphorous (mg/dl) | 7.41±0.77 | 3.2±0.49 | <0.001 |
| Ca×P product (mg ² /dl ²) | 53.84±9.49 | 32.5±5.29 | <0.0001 |

SD: Standard deviation, PTH: Parathyroid hormone, Ca × P product: Calcium × phosphorous product

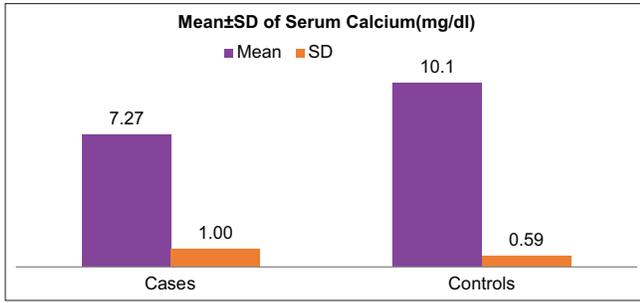


Chart 2: Comparison of serum calcium levels between CKD cases and controls

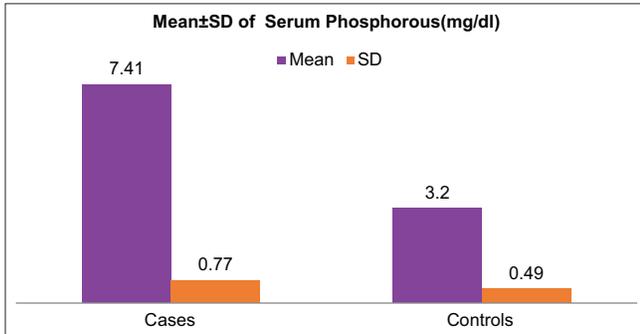


Chart 3: Comparison of serum phosphorous levels between CKD cases and controls

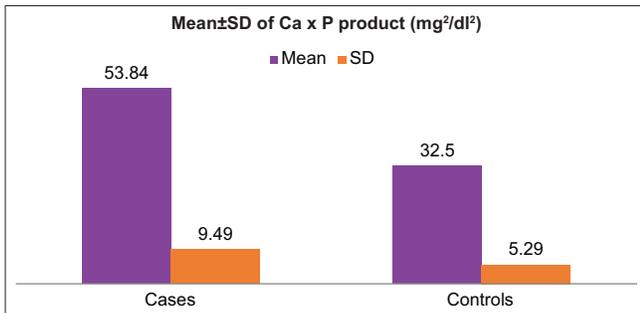


Chart 4: Comparison of calcium x phosphorous product levels between CKD cases and controls

There was positive correlation of Sr. PTH with Sr. calcium as shown in Chart 6.

There was positive correlation of Sr. PTH with Ca x P product as shown in Chart 7.

DISCUSSION

CKD is mostly associated with alterations in calcium and phosphates homeostasis resulting in increased serum PTH levels leading to hyperparathyroidism. The increased PTH levels with the progression of renal failure are a compensatory mechanism necessary to maintain the homeostasis of calcium and phosphorus metabolism and also causes myocardial calcium deposition, valvular

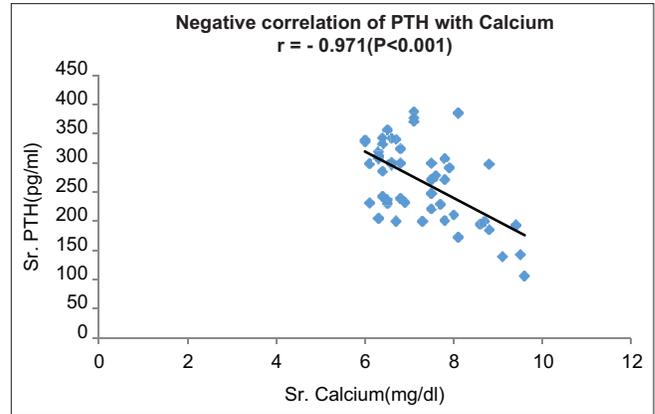


Chart 5: Correlation of Sr.PTH with Sr. calcium

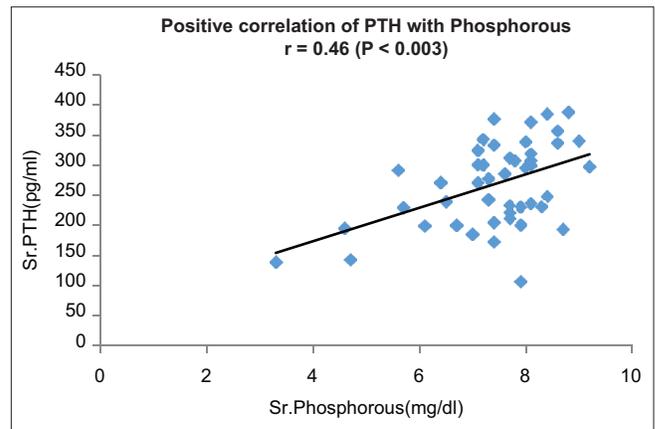


Chart 6: Correlation of Sr. PTH with Sr. phosphorous

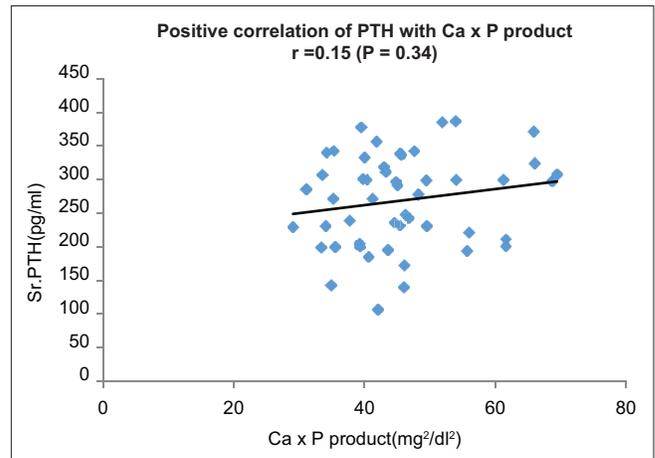


Chart 7: Correlation of Sr.PTH with Ca x P product

calcification, and vascular stiffness and calcification which leads to increased cardiovascular complications.^[8]

The serum PTH [Chart 1], serum phosphorous [Chart 3], and serum calcium x phosphorous product levels [Chart 4] levels were significantly increased ($P < 0.001$) and serum calcium [Chart 2] levels were significantly decreased ($P < 0.001$) in cases as compared to controls. Moreover,

our results were in consistent with similar studies done by Natikar *et al.*^[1] with 50 CKD cases in 2022 and by Arora *et al.*^[9] in 2018.

We observed that, among 50 CKD cases, 10% cases had Ca × P product levels more than 70 mg²/dl². The Ca × P product levels more than 70 mg²/dl² are considered as an important factor in ectopic calcification and calcific uremic arteriopathy in CKD patients.^[10] and a study done by Mario Cozzolino *et al.*^[11] reported that increased Ca × P product levels increases cardiovascular mortality in CKD patients with hyperparathyroidism.

We found a linear negative correlation of Sr.PTH with Sr. calcium with r value -0.971 [Chart 5] with significant $P < 0.001$ and a linear positive correlation of Sr. PTH with Sr. Phosphorous with $r = 0.46$ [Chart 6]) with significant $P < 0.003$ and Similar results were observed by Arora *et al.*^[9]

In our study, we observed a positive linear correlation between Sr.PTH and Ca × P product levels [Chart 7] with $r = 0.15$ but it was not significant as P -value was above 0.05 and similar observation was found by Kumar *et al.*^[2]

CONCLUSION

Increased serum PTH and calcium × phosphorous product levels in CKD patients on hemodialysis put them into risk of developing vascular calcification and pulmonary hypertension leading to increase cardiovascular

morbidity and mortality. Therefore, all CKD patients on hemodialysis need to be screened regularly for serum PTH and calcium × phosphorous product that helps to decrease the cardiovascular events and mortality in these patients.

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