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Original Article

Altered Divalent Ion Metabolism in Different Stages of Chronic Renal failure

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Abstract

A total of 50 patients (male-28, female-22), in diferent stages of chronic renal failure (Mild, CCR 30-50 ml / min / 1.73 m^2 n=17; Moderate, CCR 10 to 29 ml / min / 1.73 m2, n=15 and Severe, CCR < 10 ml / min / 1.73 m2, n=18) and 23 healthy controls (CCR 60 to 120 ml / min / 1.73 m2, male – 11, female –12) were studied in the Department of Nephrology BSMMU, Dhaka to see the alteration of divalent ion metabolism in different stages of chronic renal failure.

Mean age of the patients were 42.98 ± 14.51 years. The level of serum calcium was significantly lower among the patients of moderate and severe chronic renal failure. Serum inorganic phosphate level was significantly high among the patients of severe chronic renal failure than those of control group.

It is concluded that hypocalcaemia and hyperphosphataemia occur in the chronic renal failure patients and these are more marked in advanced chronic renal failure.

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Introduction

Disturbances of Calcium-Phosphate (Ca-P) metabolism are a known feature of chronic renal failure (CRF) and end stage renal disease (ESRD). The most important factors that triggers the disorders of calcium and phosphate metabolism in renal disease is the reduction of circulating calcitriol, which is explained by two mechanisms:

i) renal disease reduces calcitriol production due to lowered nephron mass,

ii) the hyperphosphataemia that may occur due to the decreased enzyme 1α-hydroxylase. The resultant combination of low serum Calcitriol and increased serum phosphate will ultimately produce a decrease of serum Calcium[1]

In the patients with chronic renal failure, the true intestinal calcium absorption is clearly impaired, although the defect cannot be detected with mild renal failure. The diets of these patients contain low quantities of calcium, probably contributing to hypocalcaemia in uremic patients[2]. Controversy exists regarding the aetiology of the hypocalcaemia in patients with mild renal insufficiency. The hypotheses have been proposed: (a) phosphate retention[3,4] (b) skeletal resistance to the calcaemic action of PTH[5,6] and (c) altered vitamin D metabolism. However, it is possible that these pathogenetic mechanisms are not mutually exclusive, but, rather, interrelated and together form a unified and integrated explanation for the hypocalcemea of renal insufficiency.

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The purpose of this study was to define the abnormalities of calcium and phosphorus homeostasis associated with different stages of chronic renal insufficiency.

Materials and Methods

We studied 50 patients in different stages of chronic renal failure and 23 healthy controls in the Department of Nephrology, BSMMU, Dhaka, during the period of Nov'98 to July'99. The patients of CRF were divided into three groups based on their CCR values:

1) Mild renal failure (CCR 30 to 50 ml/min/1.73 m^2) n=17
2) Moderate renal failure (CCR 10 to 29 ml/min/ 1.73 m^2)
3) Severe renal failure (CCR <10 ml/min/1.73 m^2) n=18

Patients of acute renal failure those who were taking vitamin D preparation or calcium supplements previously, with nephrotic range proteinuria ware excluded from this study.

Methods

Five millilitre fasting morning blood sample were drawn from anticubital vein of each patient and healthy control for the estimation of *Urea, Creatinine, Calcium, Inorganic phosphate, S. total protein and albumin. these were measured by auto analyser technique in the kidney research laboratory of BSMMU, Dhaka.

24 hours urine sample were collected from 06 am to 06 am on the next day and 24 hrs. urinary excretion of creatinine and protein were measured by standard technique in the kidney research laboratory of BSMMU. Creatinine clearance were calculated by standard formula and corrected for body surface. Serum calcium was adjusted with the low level of serum albumin by appropriate formula.

Statistics

All statistical analysis was performed using two-tailed tests. Statistical significance of differences between groups were determined by Anova & unpaired t test as appropriate.

Results

Twenty three healthy controls (m-11, F-12) and fifty chronic renal failure (CRF) patients (M-28, F-22) were included in this study. Mean age of control were 37.91 ± 10.07 yrs. and patients with CRF were 42.98 ± 14.51 years. (Table-I) Table-II shows the causative renal disease among the patients of CRF in different groups. Glomerulonephritis was the most common cause 28 (56%) followed by hypertension 7 (14%). ADPKD 6 (12%) and obstructive uropathy 6 (12%). When mean serum calcium level compared between groups, moderate (2.01 ± 0.17 mmol/L) and severe (1.67 ± 17 mmo./L) group (P<0.05). Severe group (1.67 ± 0.28 mmol/L) had significantly lower value than mild (2.15 ± 0.25 mmol/L) and moderate (2.01 ± 0.17 mmol/L) groups (P<0.05). There were no significant difference between control and mild groups & between mild and moderate groups (Fig- 1 & 2). Severe group had significantly higher values (2.25 ± 0.96 mmol/L) of serum Inorganic phosphate that control (1.05 ± 0.28 mmol/L) and mild (1.45 ± 0.95 mmol/L) groups (P<0.05). No significant difference was present among other groups (Fig- 3 & 4).

Table-I: Distribution of Subjects by age in Different groups

	Case				Control
	All cases Together (n=50)	Mild Group (n=17)	Moderate Group (n=15)	Severe Group (n=18)	(n=23)
Age (Years) (Mean ± SD	42.98 ± 14.51	42.94 ± 14.54	47.20 ± 15.25	39.50 ± 13.71	37.91 ± 10.-7
CCR (ml/min) (range)		30-35	10-29	<10	60-120

CCR = Creatinine Clearance rate

Table-II: Distribution of Cases by disease

Disease	Mild (n=17)	Moderate (n=15)	Severe (n=18)	Total (n=50)	
				No.	(%)
Glomerulonephrits	7	9	12	28	(56.0)
Hypertensive nephrosclerosis	4	2	1	7	(14.0)
Obstructive uropathy	2	2	2	6	(12.0)
ADPKR	2	2	2	6	(12.0)
Diabetic nephropathy	1	0	1	2	(4.0)
Others	1	0	0	1	(2.0)

ADPKD = Autosomal dominat polycystic kidney disease

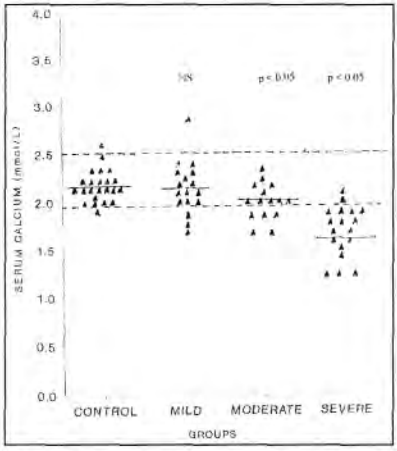

Fig. 1: Mean (±SD) serum calcium in different groups

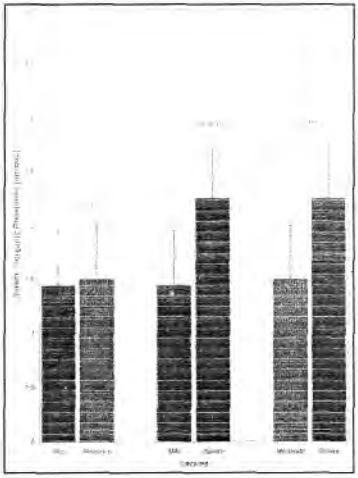

Fig. 2: Mean (± SD) Serum Inorganic Phosphate in Mild. Moderate and Severe groups NS=Not Significant

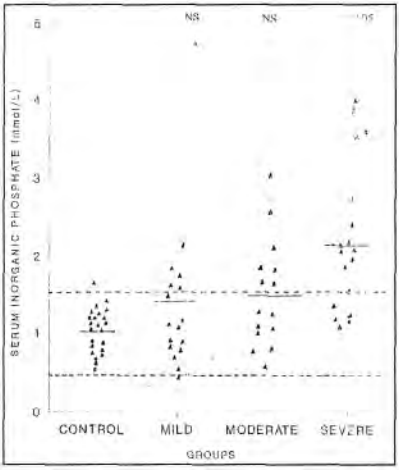

Fig. 3: Mean (± SD) Serum Inorganic Phosphate in Different Groups

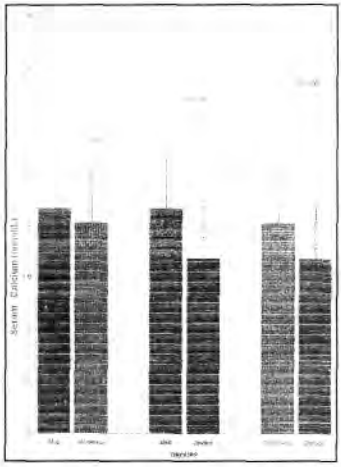

Fig. 4: Mean (± SD) Serum inorganic phosphate in different groups

Discussion

The present study was done to investigate the abnormalities of calcium and phosphorus levels in the different stages of chronic renal failure. Our data documents several abnormalities of calcium and phosphorus metabolism that occur in patients with renal parenchymal disease. Hypocalcemia was quite, prominent, however, in the patients with moderate and severe renal insufficiency and levels were significantly lower than control group. ($P<0.05$). But in few other studies, serum calcium values were in the normal range in all groups and no significant difference was present[7]. Pitts et al[8] demonstrated serum calcium level was significantly lower in end stage renal failure (CCR <20 ml/mm) group than normal subjects. In our study serum inorganic phosphate level in severe renal failure group was significantly higher than control and mild groups. This was also supported by Pitts et al[8], they found a significant higher value in end stage renal failure group than control group. But in another study serum inorganic phosphate values were in the normal range in all groups. The increase in mean serum inorganic phosphate was slightly greater in more advanced renal failure[7]. Portale et al.[9] could not demonstrated a postprandial rise in the serum phosphorus concentration in children with mild renal failure. In contrast, Wilson et al.[10] demonstrated a rise in the serum phosphorus concentration after a phosphate load in patients with CCR between 38-78 ml/mm, although the rise was less than that in normal subjects. In another study suggests that an oral phosphate load produces a sustained elevation of the serum phosphorus level in adults with mild to moderate renal insufficiency.[11] The serum inorganic phosphate concentration was elevated in our patients with severe renal failure, and thus, when all subjects were considered, it has a inverse correlation with CCR.

Conclusion

It is concluded that hypocalcemia & hyperphosphatemia occurs in the chronic renal failure patients and it is more marked in advanced chronic renal failure patients.

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