ORIGINAL ARTICLE

Calcium - Phosphate Index: Considerable Indicator in Different Stages of Chronic Kidney Disease.

Nilofar Yasmin Mili[1], Md Ehteshamul Hoque[2], Salma Akhter[3], Nasreen Sultana Lovely[4]

Abstract:

Since the early 1970s, calcium phosphate (Ca-P) index has been regarded as a risk factor for extra skeletal calcification, tumoral calcinosis and increased cardiovascular event and death. The general consensus was not to exceed 70 mg^2/dL^2 (5.6 $mmol/L^2$) in chronic kidney disease. The present study was done to find out the Ca - P index in different stages of (CKD) patients to assess the risks of the patients which can be understood and be negotiated. In this study 100 of previously diagnosed chronic kidney disease patients of different stages as CKD stage III, IV and stage V were included. Subjects were divided into three groups according to staging of chronic kidney disease : group A (stage III) were 34 patients, group B (Stage IV) were 36 and group C (Stage V) were 30 patients. Mean serum inorganic phosphate level was in group A 5.41 + 2.49, group B 8.17 + 3.63 and in group C 10.50 + 3.06. Mean serum Calcium level in three groups were in group-A 8.36± 0.74, group- B 8.10± 0.75 and in group- C was 7.43± 1.27). Ca - P index was calculated by multiplying the serum calcium and phosphate level. Mean Ca-P index was in group-A 49.39+ 22.95, group B-67.93+ 31.2 and in group-C 90.76+ 24.82. Statistical analysis was done between these groups and it was significantly higher in group B than group A (p< 0.06, group A vs group B), in group C than group A (p< 0.00, group A vs group C) and in group C than group B (p< .002, group B vs group C). It was found that as the renal function deteriorates gradually the Ca – P index increases and it is highly significantly higher in CKD – V patient than other stages.

Introduction:

Calcium - P index is the index which is calculated by multiplying serum phosphate and corrected calcium level. Normal level is 40 – 50 mg^2 of Calcium and Phosphate[1].

1. Assistant Professor, Department of Physiology, Addin Womens' Medical College, Dhaka
2. Professor of Nephrology, Holy Family red Crescent Medical College Hospital, Dhaka.
3. Associate Professor, Department of Physiology, Addin Womens' Medical College, Dhaka
4. Assistant Professor , Department of Physiology, Addin Womens' Medical College, Dhaka

Corrected calcium level means when serum albumin is lower than normal then calcium becomes spuriously lower. So measurement of serum albumin level and correction of calcium level is done by *Corrected total calcium (mg/dl) = Total calcium + 0.8 X deficient albumin (40 – serum albumin (g/dl).*

Maintenance of normal calcium balance and serum calcium levels depends on integrated regulation of calcium absorption and secretion by the intestinal tract, the excretion of calcium by the kidney and calcium release from and

deposition of calcium in to bone. Parathyroid hormone by stimulatory bone resorption and distal tubular calcium reabsorption in the kidney and activating renal hydroxylation of 25 (OH) D_3 to 1, 25 $(OH)_2$ D_3 increases serum calcium level[2]. Depression of serum calcium level by itself stimulates, through the calcium sensing receptor (CaR) in the parathyroid gland, the secretion preformed PTH from parathyroid gland within seconds. Subsequently PTH biosynthesis by parathyroid gland hypertrophy and hyperplasia, Vitamin D metabolism and serum phosphorus level also regulate PTH level in blood[3]. These homeostatic mechanism are distorted in early stage of CKD and continue to deteriorate as loss of kidney function progresses. Hypocalcaemia together with hyperphosphataemia on each individual can be responsible for increased blood Ca – P product. Since the serum phosphate levels in patients with CKD are usually increased[4].

The negative importance of serum phosphorus levels in generating higher Ca - P product expressed as mg^2/dl [5] .Still, the serum calcium levels could be critical if the serum phosphorus levels are very high which is indeed the case in patients with stage CKD -V.

Materials and method:

Subjects were selected 100 patients chronic kidney disease and were divided in three groups on the basis of creatinine clearance rate, group –A (Ccr = 60 – 89 ml/min) CKD – III (n= 34), group- B (Ccr 30 – 59 ml/min) CKD –IV (n= 36) and group –C (Ccr = 15 – 30 ml/min) CKD –V (n=30) patient. Estimation of serum calcium, s. phosphate, s. albumin were done with standard biochemical method.

Serum calcium estimated by CPC method, phosphate by colorimetric method. Serum albumin was measured to correctly estimate the serum calcium level. Because low serum albumin indicate low serum calcium. So corrected serum calcium was calculated by :

Corrected total calcium (mg/dl) = Total calcium (mg/dl) + 0.8 X {40 – serum albumin (mg/dl)}. Serum albumin was estimated by Colorimetric method.

Results:

In gr-A there were 34 patient among them Ca - P index were higher than normal only in 05 cases (14.7 %) and other 29 patients (84.3 %) index were within normal range. Among group-B there were 36 patients and out of them 13 patients (36 %) having higher Ca - P index than normal and other 23 patients (64 %) were within normal index level.

In group-C out of 30 patients only 07 cases (24 %) had normal index and other 23 cases (76 %) having very high Ca - P index.

Table-I: Comparison of Ca - P index between group -I and group- II

Group	n	Mean ± SD	P –value
A	34	49.39± 22.75	0.066
B	36	67.93 ± 31.2	0.006

Table-II: Comparison of Ca - P index between group-I and group -III

Group	n	Mean ± SD	P –value
A	34	49.39± 22.75	0.000
C	30	90.76± 24.82	0.000

Table-III: Comparison of Ca - P index between group-II and group –III

Group	n	Mean ± SD	P -value
B	36	67.93 ± 31.2	0 . 006
C	30	90.76± 24.82	0.000

Table- IV: Ca - P index in different groups

Groups	S.Alb (Mean ± SD)	Ca (Mean ± SD)	Po_4 (Mean ± SD)	Ca x Po_4 (Mean ± SD)
Group A	3.20±0.59	8.36± 0.74	5.41± 2.49	49.39± 22.75
Group B	2.78±0.47	8.10± 0.75	8.17± 3.63	67.93 ± 31.2
Group C	2.45±0.49	7.43± 1.27	10.50± 3.05	90.76± 24.82

Discussion:

Elevated serum phosphate is a predictable accompaniment of end-stage renal disease (ESRD) in the absence of dietary phosphate restriction or supplemental phosphate binders. The consequences of hyperphosphatemia include the development and progression of secondary hyperparathyroidism and a predisposition to metastatic calcification when the product of serum calcium and phosphorus (Ca - P) is elevated. Both of these conditions may contribute to the substantial morbidity and mortality seen in patients with chronic kidney disease patients[6].

Present study showed serum calcium level were gradually decreasing as the renal function deteriorates A (8.36± 0.74) in group B (8.10± 0.75) and C (7.43± 1.27) Table-I. It was significantly lower in group C than A and B (P <0.004). These findings were similar to Nordin BE[6].

In the present study the serum inorganic phosphate level in group A (5.41± 2.49), B (8.17± 3.63) and C (10.50± 3.05) were gradually increased as the creatinine clearances decreases gradually (Table –I). Pitts et al. observed that a significant higher value of phosphate in end-stage renal failure (Ccr <15 ml/min) than the other stages (P<0.01)[7]. These findings were similar to the present study.

The Ca-P index was calculated by multiplying the values of calcium and phosphate for each patient of different groups. Then we find out the mean Ca - P index and compare between the different groups. It was found that mean Ca-P index was gradually increasing in different groups according to the severity of the disease.

Changes in calcium-phosphate metabolism occur relatively early during the course of CKD- III and manifest themselves in hyperparathyroidism and decreased levels of 1,25-dihydroxyvitamin, valvular and extravascular calcification and higher levels of intact parathyroid hormone (iPTH) are associated with an increased mortality risk[9].

In this study the Ca - P index was compared in different stages of CKD and it increases gradually when the creatinine clearance decreases (Table – III). The Ca- P index was compared between the different groups and it was found that in group-B was significantly higher than group-A (p< .066) and group- C was highly significantly higher than group-B. There have been several observational studies (Lundin et al 1980, Block et al 1998, Block et al 2004, Young et al 2005) exploring the relationship between serum Ca – P product and mortality in CKD Stage- V D changes which can lead to renal bone disease[8]. A high calcium-phosphorus product is associated with artherosclerosis disease[10]. So, this is important to assase the relationship between the Ca - P index in different stage of CKD patients.

Conclusion :

The study revealed a marked increase in Ca - P index levels in all the stages of chronic kidney disease patients and it gradually increases as the renal function deteriorates more and more . It is one of the important risk factor for the chronic kidney disease, the high is the index the more is the cardiovascular risk and mortality. So, for efficient management of chronic kidney disease it may be the vital part to determine the Ca - P index and keep it within range.

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