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SERUM CALCIUM, PHOSPHORUS, MAGNESIUM AND ALBUMIN LEVELS IN PATIENTS WITH CHRONIC RENAL FAILURE IN SENNAR HOSPITAL FOR RENAL DISEASES, SENNAR STATE, SUDAN, AUGUST 2018

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ABSTRACT

Background: Chronic kidney disease (CKD) is an irreversible loss of renal function for at least three months. It is accompanied by profound changes in calcium, phosphorus, magnesium and albumin metabolism. These alterations contribute to serious complications such as cardiovascular disease and bone disease. **Objective**: This study aim to evaluate serum calcium, phosphorus, magnesium and albumin levels in patients with chronic renal failure. **Materials and Methods:** The study includes 120 samples, 80 blood samples were taken from patients with chronic renal failure in Sennar hospital for renal diseases included 44 males (55%) and 36 females (45%), the average age of the patients was 44.26 ± 19.10 years, and 40 apparently healthy individuals (control group) included 18 males (45%) and 22 females (55%) the average age of control group was 37.1 ± 18.3 years. Calcium, phosphorus, magnesium and albumin levels were measured by using chemistry analyzer A15. Statistical tests were used to assess difference in the mean of studied concentrations between cases and the control group. **Result:** The results showed that calcium and albumin concentrations were significantly lower in the patients (M±SD = 8.63 ± 1.37, M±SD = 3.39 ± 0.82) compared with controls (M±SD = 9.13 ± 0.463, M±SD = 3.8 ± 0.41, P = 0.000, P = 0.001). Phosphorus and magnesium concentrations were significantly higher in the patients (M±SD = 3.9 ± 2.07, M±SD = 2.69 ± 0.85) compared with control

group (M±SD = 3.13 ± 0.40, M±SD = 1.93 ± 0.27, *P* = 0.000, *P* = 0.000), respectively. **Conclusion:** In this study hypocalcaemia was reported in 46% of the patients, hyperphosphatemia was found in 29% of the patients, and hypermagnesemia and hypoalbuminemia were found in more than half of the patients (66%, 61%, respectively). More studies must be done to confirm these results and screening programs should be done to reduce the burden and to prevent the complications of chronic kidney disease.

KEYWORDS: Chronic Kidney Disease, Calcium, Phosphorus, Magnesium, Albumin Metabolism, Cardiovascular Disease and Bone Disease.

INTRODUCTION AND LITERATURE REVIEW

Chronic renal failure (CRF) is an irreversible loss of renal function for at least three months and poses a major public health problem (Muhammad *et.al*, 2012). It is an important source of morbidity and mortality. The most patients are asymptomatic until the disease has significantly progressed (Martin E *et.al*, 2010). The prevalence of chronic renal disease and end stage renal disease (ESRD) is increasing worldwide. The estimated prevalence of CKD in US was 16.8% while in Asia the prevalence ranged from 12.1% to 17.5% (Muhammad *et.al*, 2012). In United States, the number of patients enrolled in the end stage renal disease Medicare-funded program has increased from approximately 10,000 beneficiaries in 1973 to 615,899 as of December 31, 2011 (Gregorio and Brian, 2015). An average incidence of end stage renal disease in the Middle East is 93 per million populations. The estimated incidence for new cases in Sudan is about 70-140/million inhabitants/year (Abdelsamee *et.al,* 2012). End-stage renal disease is accompanied by profound change in minerals metabolism (Muhammad *et.al*, 2012**).** Plasma concentrations of calcium and phosphate are normally tightly regulated. Their absorption from the gut is regulated by calcitriol. Most of the absorbed calcium and phosphate is stored in the bones with very small amounts present in the circulation. Both calcium and phosphate are filtered at the glomerulus. Calcium reabsorption is increased by parathyroid hormone. Phosphate reabsorption is decreased by parathyroid hormone and increased by calcitriol (Darren and Richard, 2010). In chronic renal failure plasma phosphate concentrations rise and plasma total calcium concentrations fall. Impaired renal tubular function and the raised phosphate concentration inhibit the conversion of vitamin D to the active metabolite and this contributes to the fall of plasma calcium concentration (Martin A, 2006). This impairment result in disturbances in bone modeling and remodeling, with the associated development of fractures or impaired linear bone growth (in

children); and extra skeletal calcification in soft tissues and arteries (Ranjani and Sharon, 2011). The overall regulation of body magnesium is controlled largely by the kidney, which can reabsorb it in deficiency states or excrete excess magnesium in overload states. Renal failure is the most common cause of hypermagnesemia, which in turn result in cardiovascular, dermatologic, gastrointestinal, neurologic, neuromuscular, metabolic, and haemostatic abnormalities (Bishop, 2005). Chronic renal failure is the progressive irreversible destruction of kidney tissue by disease which, if not treated by dialysis or transplantation, will result in the death of the patient (Allan *et.al*, 1999). According to the national kidney foundation's kidney disease outcomes quality initiative (K/DOQI) guidelines, chronic renal disease is defined as sustained kidney damage indicated by the presence of structural or functional abnormalities such as microalbuminuria/ proteinuria, hematuria, histologic or imaging abnormalities, and/or reduced glumerular filtration rate (GFR) to less than 60 ml/min/1.73 m^2 for at least three months (Martin E *et.al*, 2010). The variation in disease expression is related partly to cause and pathology, severity and rate of progression (Andrew and Josef, 2012).

Because of the central role of GFR in the pathophysiology of complications, the disease is classified into five stages on the basis of GFR: more than 90 ml/min/1.73 m^2 (stage one; kidney damage with normal or elevated GFR), 60-89 ml/min/1.73 m^2 (stage two; kidney damage with mildly decreased GFR), 30-59 ml/min/1.73 m^2 (stage three; moderately decreased GFR), 15-29 ml/min/1.73 m^2 (stage four; severely decreased GFR), and less than 15 ml/min/1.73 m^2 (stage five; kidney failure; end stage renal disease), (Andrew and Josef, 2012; Martin E *et.al*, 2010). kidney failure (ESRD) is regarded as the most serious outcome of chronic kidney disease and symptoms are usually caused by complications of reduced kidney function. When symptoms are severe they can be treated only by dialysis and transplantation (Andrew and Josef, 2012). Chronic renal dysfunction is usually the end result of conditions such as diabetes mellitus, hypertension, primary glumerulonephritis, autoimmune disease, obstructive uropathy, polycystic disease, renal artery stenosis, chronic pyelonephritis, severe urinary infections, tubular dysfunction and the use of nephrotoxic drugs (Martin A, 2006). In most cases of acute oliguric renal disease there is diffuse damage involving the majority of nephrons. A patient who survives long enough to develop chronic renal disease must have some functioning nephrons (Martin A, 2006).

Consequences of CRF**:** Many of the disorders associated with uraemia are generally asymptomatic and can first be identified at GFRs of less than about 60 mL/min per 1.73 m². These disorders are more common as GFR declines (Andrew and Josef, 2012); In end stage renal failure all activities of the kidneys are affected with important metabolic consequences (Allan *et.al*, 1999).

Sodium and water metabolism: Most CRF patients retain the ability to reabsorb sodium ions, but may lose their ability to reabsorb water and so concentrate urine. Polyuria may not be excessive because the GFR is so low; Because of their impaired ability to regulate water balance, patient in renal failure may become fluid overloaded or fluid depleted very easily (Allan *et.al*, 1999).

Potassium metabolism: Hyperkalaemia is a feature of advanced CRF and poses a threat to life. The ability to excrete potassium decreases as the GFR fall, but hyperkalaemia may not be a major problem in CRF until the GFR falls to very low levels (Allan *et.al*, 1999).

Acid base balance**:** As CRF develops, the ability of the kidneys to regenerate bicarbonate and excrete hydrogen ions in the urine becomes impaired. The retention of hydrogen ions causes a metabolic acidosis (Allan *et.al*, 1999).

Erythropoietin synthesis and endocrine functions**:** Normochromic normocytic anaemia is often associated with CKD, it is due to primary failure of erythropoietin production. Biosynthesized human erythropoietin may be used to treat the anaemia of CRF. Also there are impairments in renal excretory and endocrine functions parallel reductions in GFR such as hyperprolactinaemia, insulin resistance, low plasma testosterone and abnormal thyroid function (Martin A, 2006; Allan *et.al*, 1999).

Calcium and phosphate metabolism: Early changes in chronic kidney disease are hyperphosphataemia, due to impaired excretion, and the ability of the renal cell to make 1.25 dihydroxycholecalciferol falls as renal tubular damage progresses (Darren and Richard, 2010). Calcium absorption is reduced and there is a tendency towards hypocalcaemia. Parathyroid hormone (PTH) is stimulated in an attempt to restore plasma calcium to normal, and high circulating parathyroid hormone have adverse effects on bone if this is allowed to continue. Secondary hyperparathyroidism causes the changes in bones which are characteristic of renal osteodystrophy (Allan *et.al*, 1999). Phosphate excess has been

implicated in the substantial cardiovascular morbidity and mortality observed among people who receive chronic dialysis. Hyperphosphatemia has been independently linked with calcification of the coronary arteries and aorta, as well as cardiovascular and all-cause of mortality in the setting of ESRD. Control of hyperphosphatemia is an integral component of the routine care of chronic dialysis patients (Rapesh Raina *et.al*, 2012).

Magnesium metabolism: Renal excretion is the major route of magnesium elimination from the body and a positive magnesium balance would be expected under conditions of renal insufficiency. However, a compensatory decrease in tubular reabsorption is operating to maintain an adequate urinary magnesium excretion even when glomerular filtration rates are very low. Nevertheless, in end-stage renal disease, the limited ability of the kidney to excrete an increased magnesium load may result in toxic concentrations of the ion in serum (Mountokalakis, 1990).

Diagnosis of chronic kidney disease**:** Patients with early stage of chronic kidney disease are generally asymptomatic. Many of such cases remain undiagnosed and later progress to end stage renal disease. They often present late with complications of CKD. To reduce the prevalence of end stage renal disease, effective screening and treatment methods for chronic renal disease should be established. Early detection and intervention of high risk groups may prevent the development and progression of chronic renal disease. Patients with diabetes mellitus and/or hypertension should be screened at least yearly for chronic kidney disease. Screening can also be considered for high risk patients with: age more than 65 years old, family history of end stage renal disease or hereditary renal disease, structural renal tract disease, renal calculi or prostatic hypertrophy, chronic use of non-steroidal anti inflammatory drugs (NSAIDs) or other nephrotoxic drugs, cardiovascular disease and multisystem diseases with potential kidney involvement such as systemic lupus erythematosus (SLE). Laboratory tests for detection and staging of chronic renal disease include estimated glumerular filtration rate (eGFR) based on the modification diet of renal disease (MDRD) equation. Serum creatinine also should be used in combination with estimated glumerular filtration rate in the assessment of renal function. Serum creatinine is affected by many variables such as age, gender, ethnicity, muscle mass and protein meal, and should not be used as an independent marker of kidney function. Furthermore, serum creatinine is not a sensitive marker of early chronic renal disease as it will rise only after a reduction of renal function by at least 50% (Muhammad *et.al*, 2012).

JUSTIFICATION

- The prevalence of chronic renal disease and end stage renal disease is increasing worldwide (Muhammad *et.al*, 2012). Also, the high costs and poor outcomes of treatment constitute a worldwide public health threat. Costs for dialysis and transplantation are increasing (Andrew and Josef, 2012). Patients with ESRD consume a disproportionate share of healthcare resources. The total cost of the ESRD program in the US was approximately $49.3 billion in 2011. Medicare costs per person per year were more than $75,000 overall, ranging from $32,922 for transplant patients to $87,945 for those receiving hemodialysis therapy (Gregorio and Brian, 2015).

- End-stage renal disease (ESRD) is accompanied by profound changes in mineral metabolism (calcium, phosphorus and magnesium), which in turn contributes to bone disease, cardiovascular disease, and other clinical problems (Eric *et.al*, 2005).

OBJECTIVES

General objective

- To evaluate serum calcium, phosphorus, magnesium and albumin levels in patients with chronic renal failure.

Specific objectives

- To measure serum calcium, phosphorus, magnesium and albumin levels in patients with chronic renal failure and healthy individuals (control group) using chemistry analyzer A15.

MATERIALS AND METHODS

Study area and study population:

Sennar State is part of the Blue Nile region in South-East Sudan and is delimited by Al-Gazira State in the North, The Blue Nile in the South, Algadarif State and the Sudanese Ethiopian borders in the East and the White Nile State in the West. The area approximately is 40,680 kilometers square with population 1,400,000 persons The state contains seven localities and Singa city is the capital of the state (sudan.gov.sd, 2012). This study was conducted in Sennar state in Sennar hospital for renal diseases. The hospital located in the north part of Sennar city, it has a capacity of treating twelve patients at a time using 12 haemodialysis machines. Its staff consists of about 20 persons. Volunteer patients with chronic renal failure were participated in this study.

Study design

Case-control study.

Sample size

The study includes 120 samples. 80 blood samples were collected from patients with chronic renal failure, and 40 samples from healthy individuals (control group).

$$N = \frac{4 \times P \times Q}{L2}$$

N: Sample Size. P: Prevalence. L: desired absolute precision. Q: 1-P. (Martin et al 1987).

Data collection and analysis

Data was collected by using a questionnaire. A sufficient copy of the questionnaire was produced. Questionnaires were then filled by the investigator during each time when blood samples collected. Completed questionnaires from selected study areas (120) were collected. Data was then analyzed and tabulated using statistical package for social sciences (IBM SPSS) program version 20, T test, a crosstabs and correlation were performed.

Study variables

Dependent variables

- Calcium, phosphorus, magnesium and albumin.

Independent variables

- Age, sex, blood pressure, disease duration and bone problems (appendix).

Materials and equipment

The following materials and equipments were utilized in this study

- A15 analyzer, serial No. 331054841 (Biosystem, Barcelona-Spain).
- Centrifuge, D. 87532 (Germany Hettich), and Automatic pipette.
- Syringes, gloves, alcohol (70% ethanol) and plain containers.

Blood sampling and Collection

About 3ml of venous blood were collected from the participants by using a sterile needle and syringe into a labeled plain container. Each sample was stood until complete clot occurs. Clotted blood sample was then centrifuged to obtain the serum. All Sera were kept at −20°C until using for measurement of calcium, phosphorus, magnesium and albumin levels.

METHODS

Calcium

Principle

Calcium in the sample reacts with o-cresolphthalein comlexone (o-CPC) forming a coloured complex that can be measured by spectrophotometry.

Procedure

Volumes	Sample	4 µL
	Reagent 1	240 µL
	Incubation for 96 second	
	Reagent 2	60 µL
	Washing	1.2 µL
Times	Reading 1	72 s
	Reading 2	312 s
Filter	Main	560 nm

Reference value

Serum: 8.6-10.3 mg/dl.

Phosphorus

Principle

Inorganic phosphorus in the sample reacts with molbdate in acid medium forming a phosphomolybdate complex that can be measured by spectrophotometry.

Procedure

Volumes	Sample	3 µL
	Reagent 1	210 µL
	Incubation for 96 second	
	Reagent 2	90 µL
	Washing	1.2 µL
Times	Reading 1	72 s
	Reading 2	312 s
Filter	Main	340 nm

Reference value

Adults: 2.5-4.5 mg/dl.

Children: 4.0-7.0 mg/dl.

Magnesium

Principle

Magnesium on the sample reacts with xylidyl blue in alkaline medium forming a coloured complex that can be measured by spectrophotometry.

Procedure

Volumes	Sample	3 µL
	Reagent 1	300 µL
	Washing	1.2 µL
Time	Reading 1	505 nm
Filter	Main	312 s

Reference value

Serum: 1.7-2.4 mg/dl.

Albumin

Principle of the method

Albumin in the sample reacts with bromocresol green in acid medium forming a coloured complex that can be measured by spectrophotometry.

Procedure

Volumes	Sample	3 µL
	Reagent 1	300 µL
	Washing	1.2 µL
Time	Reading 1	72 s
Filters	Main	635 nm
	Reference	670 nm

Reference value

Adults: 3.5-5.0 mg/dl.

Children: 3.8-5.4 mg/dl.

Elder: 3.4-4.8 mg/dl.

RESULTS

This study was carried out on 80 patients with chronic renal failure (cases) and 40 apparently healthy individual (control) at different ages and sex to determine the effect of chronic renal failure on calcium, phosphorus, magnesium and albumin level.

The age range of the patients was 8-80 years with mean of 44.26 ± 19.10 years, 7 (9%) children, 43 (54%) adult and 30 (37%) elder. 44 (55%) were male and 36 (45%) were female, 51 (64%) of them have uncontrolled blood pressure, 47 (58%) have bone problems, and the disease duration range was 4-84 months with mean of 36.56 ± 20.25, (Table 4.1).

Table 4.1: General characteristics of patients.

Characteristic	Frequency (%)	M±SD
Age		44.26 ± 19.10
Gender		
Male	44 (55%)	
Female	36 (45%)	
Blood pressure		
Controlled	29 (36%)	
Uncontrolled	51 (64%)	
Duration of disease		36.56 ± 20.25
Bone problems		
Bone pain	34 (43%)	
Unwalked	10 (13%)	
Fracture	3 (2%)	
Calcium		8.63 ± 1.37
Phosphorus		3.9 ± 2.07
Magnesium		2.69 ± 0.85
Albumin		3.39 ± 0.82

The mean age of the control group was M±SD = 37.1 ± 18.3 years, 18 (45%) were male and 22 (55%) were female. After conducting the appropriate tests the following results were obtained: Calcium and albumin concentrations were significantly lower in the patients (M±SD = 8.63 ± 1.37 M±SD = 3.39 ± 0.82) compared with controls (M±SD = 9.13 ± 0.463, M±SD = 3.8 ± 0.41, P = 0.000, P = 0.001). Phosphorus and magnesium concentrations were significantly higher in the patients (M±SD = 3.9 ± 2.07, M±SD = 2.69 ± 0.85) compared with control group (M±SD = 3.13 ± 0.40, M±SD = 1.93 ± 0.27, P = 0.000, P = 0.000), respectively, (Table 4.2).

Table 4.2: The mean of serum calcium, phosphorus, magnesium and albumin in cases and controls.

Parameters	**Cases** (M±SD)	**Control** (M±SD)	***P. value***
Calcium	8.63 ± 1.372	9.13 ± 0.463	0.000
Phosphorus	3.9 ± 2.07	3.13 ± 0.404	0.000
Magnesium	2.69 ± 0.851	1.93 ± 0.267	0.000
Albumin	3.39 ± 0.819	3.8 ± 0.405	0.001

There was no statistical significant differences in serum calcium, phosphorus, magnesium and albumin levels between patients with and without a history of hypertension (*P* 0.66, *P* 0.88, *P* 0.23 and *P* 0.30, respectively), (Table 4.3).

Table 4.3: The mean of serum calcium, phosphorus, magnesium and albumin levels between patient with controlled and uncontrolled blood pressure.

	Control n = 29	Uncontrolled n = 51	P. Value
Total Calcium	8.68± 1.09	8.63± 1.45	0.664
Serum phosphorus	4.20± 2.28	3.76± 1.90	0.878
Serum magnesium	2.73± 0.60	2.66± 0.76	0.234
Serum albumin	3.44± 1.01	3.35± 0.54	0.299

4.1.1 Calcium

The distribution of the serum calcium concentrations relative to the reference range (Figure 4.1). 38 (48%) of patients was found to have a serum calcium concentration within the reference range, 37 (46%) of patients have a serum calcium concentration below the reference range, and only 5 (6%) were exceeded the target range.

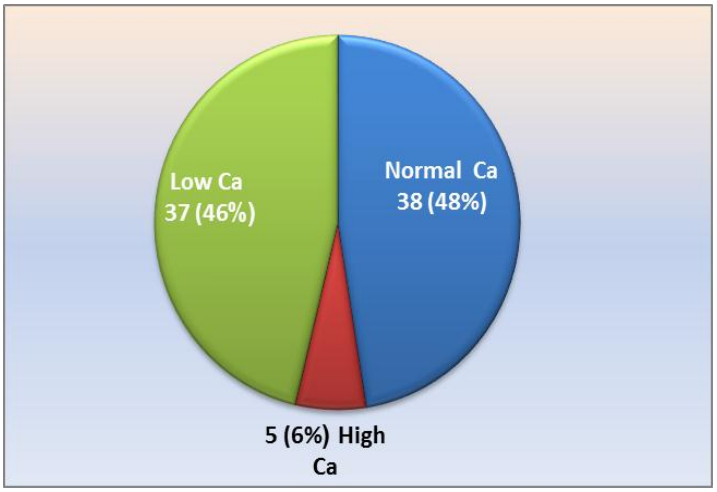

Figure 4.1: Distribution of Calcium levels among patients.

There is no statistical significant correlation between calcium and age (*P*. 0.26), gender (*P*. 0.74), blood pressure (*P*. 0.50), duration of disease (*P*. 0.91) and bone problems (*P* 0.26), (Table 4.4).

Table 4.4: Comparison between patients with normal, high and low serum calcium.

Characteristics	N. calcium	High calcium	Low calcium	*P*. value
Gender				
Male	22 (58%)	2 (40%)	20 (54%)	0.74
Female	16 (42%)	3 (60%)	17 (46%)	
Age				
Children	3 (9%)	1 (20%)	3 (8%)	0.26
Adults	17 (44%)	4 (80%)	22 (60%)	
Elders	18 (47%)	0 (0%)	12 (32%)	
Duration of disease (month)				
4-20	8 (21%)	1 (20%)	10 (27%)	0.91
21-40	15 (40%)	2 (40%)	11 (30%)	
41-60	13 (34%)	2 (40%)	12 (32%)	
61-84	2 (5%)	0 (0%)	4 (11%)	
Bone problems				
No, pain	13 (34%)	3 (60%)	17 (46%)	0.26
Bone pain	17 (44%)	1 (20%)	16 (43%)	
Un walked	6 (17%)	0 (0%)	4 (11%)	
Fracture	2 (5%)	1 (20%)	0 (0%)	

4.1.1.1 Abnormal calcium levels and gender

Of 37 patients with low serum calcium level, 20 (54%) are male and 17 (46%) are female and of 5 patients having high serum calcium level, 3 (60%) are female and 2 (40%) are male, (Table 4.4).

4.1.1.2 Abnormal calcium levels and age

22 (60%) of those patients having low serum calcium level are adults, 12 (32%) are elder and only 3 (8%) are children. Of 5 patient with high serum calcium level, 4 (80%) are adults and 1 (20%) are children, (Table 4.4).

4.1.1.3 Abnormal calcium levels and disease duration

10 (27%) of patients with low serum calcium are within the group of patients having the disease for about 4-20 months, 11 (30%) are within the disease duration range of 21-40 months, 12 (32%) are in the range of 41-60 months and 4 (11%) are within the range of 61-84 months. Of 5 patients high serum calcium level; 1 (20%) belong to the group of patients suffering from the disease for about 4-20 months, 2 (40%) are in the range of 21-40 months and the other 2 (40%) are within the disease duration range of 41-60 months, (Table 4.4).

4.1.1.4 Abnormal calcium levels and bone problems

17 (46%) of patients with low serum calcium level have no features of bone problems, 16 (43%) have bone pain and 4 (11%) are unwalked. Of 5 patients with high serum calcium level; 3 (60%) have no features of bone problems, 1 (20%) have bone pain and 1 (20%) suffering from bone fracture, (Table 4.4).

4.1.2 Phosphorus

The distribution of the serum phosphorus concentrations relative to the reference range (Figure 4.2). 36 (45%) of patients was found to have a serum calcium concentration within the reference range. The serum phosphorus concentration was above the upper range limit in 23 (29%) of patients and below the lower range limit in 21 (26%) of patients.

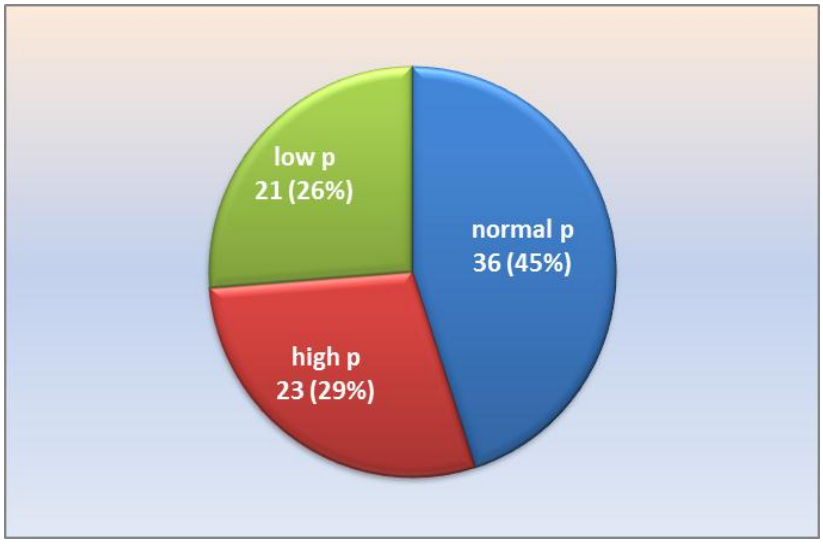

Figure 4.2: Distribution of phosphorus levels among patients.

There is statistical significant correlation between phosphorus and gender and age (*P*. value 0.003, *P*. value 0.000). There is no statistical significant correlation between phosphorus, blood pressure, duration of disease and bone problems (*P*. value 0.69, *P*. value 0.11, *P*. value 0.81), (Table 4.5).

Table 4.5: Comparison between patients with normal, high and low serum phosphorus.

Characteristics	N. phosphorus	H. phosphorus	L. phosphorus	*P*. value
Gender				
Male	25 (69%)	14 (61%)	5 (24%)	0.003
Female	11 (31%)	9 (39%)	16 (76%)	
Age				
Children	0 (0%)	1 (5%)	6 (29%)	0.000
Adults	17 (47%)	18 (78%)	8 (38%)	

Elders	19 (53%)	4 (17%)	7 (33%)	
Duration of disease (month)				
4-20	9 (25%)	7 (30%)	3 (14%)	0.11
21-40	17 (47%)	7 (30%)	4 (19%)	
41-60	7 (20%)	8 (35%)	12 (57%)	
61-84	3 (8%)	1 (5%)	2 (10%)	
Bone problems				
No, pain	13 (36%)	9 (39%)	11 (53%)	0.81
Bone pain	16 (44%)	11 (48%)	7 (33%)	
Un walked	5 (14%)	2 (8%)	3 (14%)	
Fracture	2 (6%)	1 (5%)	0 (0%)	

4.1.2.1 Abnormal phosphorus levels and gender

Of 21 patients with low serum phosphorus level, 5 (24%) are male and 16 (76%) are female and of 23 patients having high serum phosphorus level, 14 (61%) are male and 9 (39%) are female, (Table 4.5).

4.1.2.2 Abnormal phosphorus levels and age

8 (38%) of those patients having low serum phosphorus level are adults, 7 (33%) are elder and only 6 (29%) are children. Of 23 patients with high serum phosphorus level, 18 (78%) are adults, 4 (17%) are elder and 1 (5%) are children, (Table 4.5).

4.1.2.3 Abnormal phosphorus levels and disease duration

3 (14%) of patients with low serum phosphorus are within the group of patients having the disease for about 4-20 months, 4 (19%) are within the disease duration range of 21-40 months, 12 (57%) are in the range of 41-60 months and 2 (10%) are within the range of 61-84 months. Of 23 patients high serum phosphorus level; 7 (30%) belong to the group of patients suffering from the disease for about 4-20 months, 7 (30%) are in the range of 21-40 months, 8 (35%) are within the disease duration range of 41-60 months and the other 1 (5%) are in the range of 61-84 months, (Table 4.5).

4.1.2.4 Abnormal phosphorus levels and bone problems

11 (53%) of patients with low serum phosphorus level have no features of bone problems, 7 (33%) have bone pain and 3 (14%) are unwalked. Of 23 patients with high serum phosphorus level; 9 (39%) have no features of bone problems, 11 (48%) have bone pain, 2 (8%) are un walked and 1 (5%) suffering from bone fracture., (Table 4.5).

4.1.3 Magnesium

The distribution of the serum magnesium concentrations relative to the reference range (Figure 4.3), 22 (28%) of patients was found to have a serum magnesium concentration within the reference range. More than half the patients 53 (66%) exceeded the upper range limit, the remaining 5 (6%) was found to have a serum magnesium concentration below the reference range.

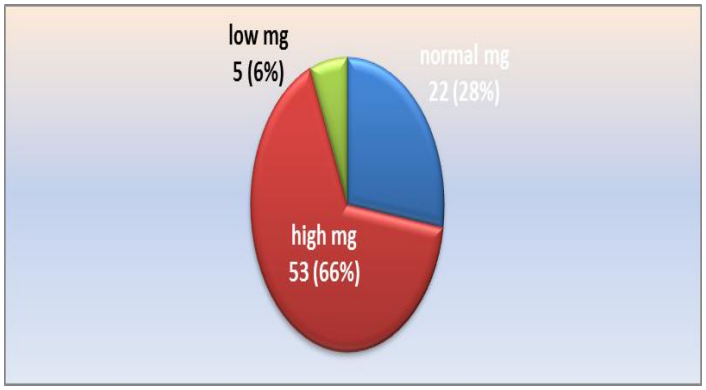

Figure 4.3: Distribution of magnesium levels among patients.

There is statistical significant correlation between magnesium and blood pressure (*P*. value 0.007). There is no statistical significant correlation between magnesium and age (*P*. 0.37), gender (*P*. 0.86), duration of disease (*P*. 0.55) and bone problems (*P*. 61), (Table 4.6).

Table 4.6: Comparison between patients with normal, high and low serum magnesium.`

Characteristics	N. magnesium	H. magnesium	L. magnesium	*P*. value
Gender				
Male	13 (59%)	28 (53%)	3 (60%)	0.86
Female	9 (41%)	25 (47%)	2 (40%)	
Age				
Children	1 (5%)	6 (11%)	0 (0%)	0.37
Adults	10 (45%)	31 (59%)	2 (40%)	
Elders	11 (50%)	16 (30%)	3 (60%)	
Duration of disease (month)				
4-20	7 (32%)	12 (23%)	0 (0%)	0.55
21-40	9 (41%)	17 (32%)	2 (40%)	
41-60	5 (22%)	19 (36%)	3 (60%)	
61-84	1 (5%)	5 (9%)	0 (0%)	
Bone problems				
No, pain	12 (54%)	19 (36%)	2 (40%)	0.61
Bone pain	9 (41%)	23 (43%)	2 (40%)	
Un walked	1 (5%)	8 (15%)	1 (20%)	
Fracture	0 (0%)	3 (6%)	0 (0%)	

4.1.3.1 Abnormal magnesium levels and gender group

Of 5 patients with low serum magnesium level, 3 (60%) are male and 2 (40%) are female. And of 53 patients having high serum magnesium level, 28 (53%) are male and 25 (47%) are female, (Table 4.6).

4.1.3.2 Abnormal magnesium levels and age group

2 (40%) of those patients having low serum magnesium level are adults and 3 (60%) are elder. Of 53 patients with high serum magnesium level, 31 (59%) are adults, 16 (30%) are elder and 6 (11%) are children, (Table 4.6).

4.1.3.3 Abnormal magnesium levels and disease duration

2 (40%) of patients with low serum magnesium level are within the disease duration range of 21-40 months and the other 3 (60%) are in the range of 41-60 months. Of 53 patients high serum magnesium level; 12 (23%) belong to the group of patients suffering from the disease for about 4-20 months, 17 (32%) are in the range of 21-40 months, 19 (36%) are within the disease duration range of 41-60 months and the other 5 (9%) are in the range of 61-84 months, (Table 4.6).

4.1.3.4 Abnormal magnesium levels and bone problems

2 (40%) of patients with low serum magnesium level have no features of bone problems, 2 (40%) have bone pain and 1 (20%) are unwalked. Of 53 patients with high serum magnesium level; 19 (36%) have no features of bone problems, 23 (43%) have bone pain, 8 (15%) are un walked and 3 (6%) suffering from bone fracture, (Table 4.6).

4.1.4 Albumin

The distribution of the serum albumin concentrations relative to the reference range (Figure 4.4), 30 (38%) of patients was found to have a serum albumin concentration within the reference range. More than half the patients 49 (61%) was found to have a serum albumin concentration below the reference range, the remaining 1 (1%) exceeded the upper range limit.

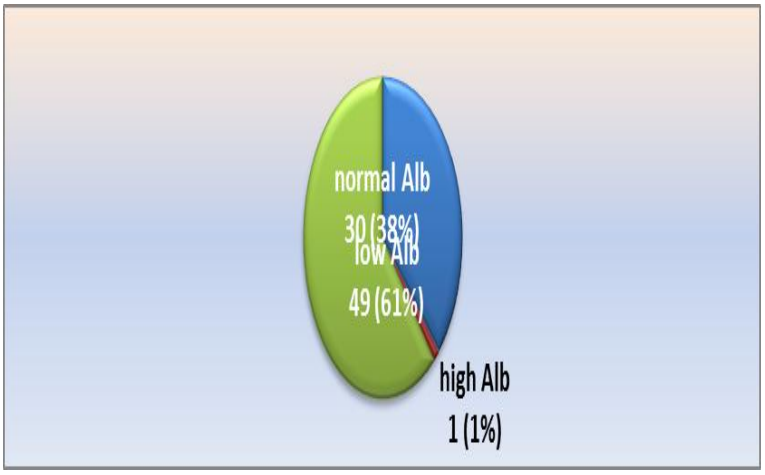

Figure 4.4: Distribution of albumin levels among patients.

There is statistical significant correlation between albumin and bone problems (*P*. value 0.000). There is no statistical significant correlation between albumin and age (*P*. 0.13), gender (*P*. 0.49), blood pressure (*P*. 0.30) and duration of disease (*P*. 0.60), (Table 4.7).

Table 4.7: Comparison between patients with normal, high and low serum albumin.

Characteristics	N. albumin	H. albumin	L. albumin	*P*. value
Gender				
Male	18 (60%)	1 (100%)	25 (51%)	0.49
Female	12 (40%)	0 (0%)	24 (49%)	
Age				
Children	0 (0%)	0 (0%)	7 (14%)	0.13
Adults	20 (67%)	1 (100%)	22 (45%)	
Elders	10 (33%)	0 (0%)	20 (41%)	
Duration of disease (month)				
4-20	7 (23%)	0 (0%)	12 (24%)	0.60
21-40	13 (44%)	0 (0%)	15 (31%)	
41-60	7 (23%)	1 (100%)	19 (39%)	
61-84	3 (10%)	0 (0%)	3 (6%)	
Bone problems				
No, pain	10 (33%)	0 (0%)	23 (47%)	0.000
Bone pain	14 (47%)	0 (0%)	20 (41%)	
Un walked	4 (13%)	0 (0%)	6 (12%)	
Fracture	2 (7%)	1 (100%)	0 (0%)	

4.1.4.1 Abnormal albumin levels and gender

Of 49 patients with low serum albumin level, 25 (51%) are male and 24 (49%) are female. And only one male have high serum albumin level, (Table 4.7).

4.1.4.2 Abnormal albumin levels and age

22 (45%) of those patients having low serum albumin level are adults, 20 (41%) are elder and 7 (14%) are children. Only one adult male have high serum albumin level, (Table 4.7).

4.1.4.3 Abnormal albumin levels and disease duration

12 (24%) of patients with low serum albumin are within the group of patients having the disease for about 4-20 months, 15 (31%) are within the disease duration range of 21-40 months, 19 (39%) are in the range of 41-60 months and 3 (6%) are within the range of 61-84 months. The only one patient with high serum albumin level is belong to the group of patients suffering from the disease for about 41-60 months, (Table 4.7).

4.1.4.4 Abnormal albumin levels and bone problems: 23 (47%) of patients with low serum albumin level have no features of bone problems, 20 (41%) have bone pain and 6 (12%) are unwalked. The only one patient with high serum albumin level is suffering from bone fracture, (Table 4.7).

DISCUSSION

The results reveal that calcium and albumin concentrations were significantly lower in the patients compared with controls. In contrast phosphorus and magnesium concentrations were significantly higher in the patients compared with control group, this indicates that chronic renal failure has effect on the serum calcium, phosphorus, magnesium and albumin levels. As the glumerular filtration rate (GFR) declines to < 60 ml/min/1.73 m^2, phosphorus excretion becomes altered in the nephron. Although half of the nephrons are not working to excrete phosphorus, the remaining nephrons compensate by hyper-excreting the daily phosphorus load to maintain normal phosphorus concentrations. Compensation can generally continue until the glumerular filtration rate declines to 25-40 ml/min/1.73 m^2. With progressive chronic renal disease, when the remaining nephrons can no longer sufficiently excrete the phosphorus load, hyperphosphatemia is detected (Sarah, 2008). During the course of chronic renal disease; total serum calcium tends to decrease as result of phosphate retention and decreased production of 1.25 dihydroxycholecalciferol from the kidney and decreased intestinal calcium absorption (Kevin, 2010). Hypermagnesemia in patients with end stage renal disease presumably relates to relative normal gastrointestinal absorption, possibly due to low 1.25 dihydroxycholecalciferol level, and impaired net kidney excretion (David, 2011). Hypoalbuminemia is common in patients with chronic renal disease, it is a significant risk factor for cardiovascular disease (Nehal and Francis, 2008). Study was done by Nahid and

AbdElkarim in Khartoum Teaching Hospital – Khartoum - Sudan showed that calcium concentrations were lower in the patients (M±SD = 9.5 ± 0.83 mg/dl) compared with controls (M±SD =9.7 ± 0.57 mg/dl), the difference did not reach statistical significance (*P* 0.07). And phosphorus concentrations were significantly higher in the patients (M±SD = 4.7±1.8 mg/dl) compared with control group (M±SD = 3.6±0.47 mg/dl, *P* 0.00); this agree with my result. In this study hypocalcemia was reported in 46% of the patients, hyperphosphatemia was found in 29% of patients, and hypermagnesemia and hypoalbuminemia were found in more than half of patients (66%, 61%, respectively). Study was done by Mohammad Reza *et.al* in University of Medical Sciences – Tehran – Iran showed that; of 103 patients with chronic renal failure and under regular haemdialysis, 1% had hypomagnesemia, 39.8% had magnesium level within normal range and 59.2% had hypermagnesemia. In this study more than half of patients had hypermagnesemia and this agree with my result. Also they reported that there is no significant correlation between serum magnesium level and age and sex. This study showed that there are no statistical significant differences in serum calcium, phosphorus, magnesium and albumin levels between patients with and without a history of hypertension, and disease duration. Also the results of this study reveal that there are no statistical significant differences in calcium, magnesium and albumin in terms of age and sex. In contrast, there were statistical significant differences in serum phosphorus with age and sex. In addition, the results obtained that there are no noticeable correlation between serum calcium, phosphorus and magnesium, and bone problems. But there is a significant difference between serum albumin and bone problems. Also in Nahid and AbdElkarim study there was statistical significant correlation between phosphorus and duration of disease (*P* 0.02). But was no statistical significant correlation between calcium and duration of disease (*P* 0.3).

CONCLUSION

This study concluded that calcium and albumin concentrations were significantly lower in the patients compared with controls. In contrast phosphorus and magnesium concentrations were significantly higher in the patients compared with control group, this indicates that chronic renal failure has effect on the serum calcium, phosphorus, magnesium and albumin levels. Hypocalcemia was reported in 37 (46%) of the patients, hyperphosphatemia was found in 23 (29%) of patients, and hypermagnesemia and hypoalbuminemia were found in more than half of patients (53 (66%), 49 (61%), respectively). There are no significant differences in serum calcium, phosphorus, magnesium and albumin levels between patients with and without a history of hypertension, and disease duration. Also there are no significant differences in

calcium, magnesium and albumin in terms of age and sex. In contrast, there were significant differences in serum phosphorus with age and sex.

RECOMENDATIONS

More studies including a larger population size and equally distributed variables should be done to confirm these results. Screening programs should be improved to reduce the burden and to prevent the complications of CKD.

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