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Original Research Article

Evaluation of minerals, urea, and creatinine in chronic renal failure

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ABSTRACT

In chronic renal failure, there is gradual damage to kidneys. Minerals alter in renal failure patients because of impairment in renal function.

Objective: To evaluate the significance of minerals in chronic renal failure patients was the focus of the study.

Materials and Methods: This is a case-control study. The study included sixty individuals within the age group of 30 -70 years and was selected randomly in the year 2018 over a period of six months in the Department of Biochemistry and Nephrology of ASRAM medical college, AP. Thirty subjects were taken as a control group (Group A) and thirty subjects of chronic renal failure who are clinically diagnosed based on the creatinine value $>$ 7.0 mg/ dl as cases (Group B). The parameters RBS, creatinine, urea, sodium, potassium, magnesium, phosphorus, iron and calcium were analyzed by Automated Chemistry Analyzer; Beckman Coulter AU 480.

Results: The subjects within the age of 30-70 years were taken. Comparison between the results of controls and cases (CRF) of biochemical variables (RBS, creatinine, urea, sodium, potassium, magnesium phosphorous, iron and calcium) has shown statistical significance. Comparison of CRF subjects, based on gender has shown statistically no remarkable difference in RBS, creatinine, urea, sodium, potassium, magnesium phosphorous, iron and calcium. Levels of all biochemical variables in CRF with hypertension versus CRF with both hypertension and DM cases do not show any statistical significance.

Conclusion: Serum levels of RBS, creatinine, urea, potassium, magnesium and phosphorus showed a remarkable increase in CRF patients w hen compared to the control group. Serum levels of sodium, calcium and iron showed a remarkable decrease in CRF patients than those in the control group.

1. Introduction

Chronic renal failure has become a public health issue. The prevalence of CKD in India, according to a study is 13 -15.04%.[1] Diabetes and hypertension are related to risk factors for CRF. In India diabetes and hypertension account for 40-60% cases of CRF.[1] End-stage renal disease (ESRD) is induced by a continuous decrease in kidney function. In Chronic renal failure, there is continuous loss of renal function whatever may be the fundamental cause of the kidney disease. The fundamental cause of CRF has shifted from principle causes such as glomerulonephritis and interstitial nephritis to atherosclerosis and diabetic nephropathy. A rapid permanent loss of kidney function is due to progressive glomerulopathies. In chronic renal failure, the change of renal parameters and minerals in the blood is due to the continuous decline in the glomerular filtration rate. GFR of lower than 60 ml/minute/1.73 m^2 is the indication of CKD according to Kidney Disease Improving Global Outcomes (KDIGO). CKD is further graded into five stages. In CKD stage five GFR is less than 15 ml/minute.[2] Serum creatinine is greater than 5.0 mg/dl in men and greater than 4.0 mg/dl in women in stage five CKD.[3] Kidney diseases that cause kidney damage can be diagnosed in urine specimens by albuminuria and albumin-to-creatinine ratio $>$ 30 mg/g^3. B lood vessels in

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the kidney are impaired by hypertension and results in the accumulation of waste products.[4,5]

Creatinine is anhydride and excretory form of creatine. Creatine is a tripeptide made of glycine, arginine, and methionine. Urea, creatinine are substances produced from arginine, an amino acid present in the liver (urea cycle) and also in the kidney which is primarily excreted by glomerular filtration. As the number of functioning nephrons is gradually reduced, these substances are retained and their concentration in the blood rises.[6] Most of the diseases of kidney progress to end-stage renal failure proportionately free of the initial disease. Water, electrolytes and minerals disturbances are furnished in chronic renal failure.[7] Minerals are essential for the growth and maintenance of the body to function properly. Sodium, potassium, calcium, magnesium, iron, and phosphorus are common minerals. Diet of chronic renal failure patients should change according to the number of minerals in their bodies. The level of serum magnesium increases when the glomerular filtration rate (GFR) drops below 20 – 30 mL/min.[8] Homeostasis of magnesium is maintained by intestinal absorpt ion and excretion by kidneys. The excretion of magnesium is determined by filtration and reabsorption. The renal handling of magnesium depends to a great extent on the p lasma magnesium concentration. The fractional excretion of magnesium is high, in hypermagnesemia and in hypomagnesemia, it is low.[9] Chronic kidney disease (CKD) patients have CKD-mineral bone disorder (CKD-MBD)[10] where they have marked disturbance in bone and mineral metabolism. Sodium is essential for normal muscle irritability. Sodium helps to maintain blood volume and controls blood pressure. Chronic renal failure patients suffer from high sodium level which not only increases patient's blood pressure but also causes fluid retention in the body. This study was undertaken to evaluate the importance of common minerals in chronic renal failure before dialysis.

2. Materials and Methods

This is a case-control study. A total of sixty subjects in the age group of 30-70 years were selected randomly in the year 2018 over a period of six months in the Department of Biochemistry and Nephrology of ASRAM medical college, Eluru, AP after getting approval from the Institutional Ethical Committee of Alluri Sitarama Raju Academy of Medical Sciences and informed consent were taken from all the subjects. Thirty subjects were taken as a control group (Group A) and thirty clinically diagnosed cases of chronic renal failure patients based on the creatinine value > 7.0 mg/dl as cases (Group B).[3] From the subjects, 5ml of venous blood was drawn and allowed to stand for 30 minutes, then centrifuged at 2500 RPM for ten minutes and samples were analyzed.

The parameters RBS, creatinine, urea, sodium, potassium, magnesium phosphorous, iron and calcium were analyzed by Automated Chemistry Analyzer; Beckman Coulter AU480. RBS was analyzed by Hexokinase method**,** Creatinine was analyzed by Jaffe's method**,** Urea was analyzed by GLDH method, Sodium, Potassium was analyzed by ISE Direct method, Magnesium was analyzed by Xylidyl blue method, Phosphorous was analyzed by Molybdate UV method, Iron was analyzed by TPTZ method and Calcium was analyzed by Arsenazo ——— method. Hypertensive patients, diabetes mellitus patients, and chronic renal failure patients were involved in the study. Persons who came to ASRAM h ospital outpatient department for health check-up are the healthy controls and were involved in the study. Patients with thyroid disorders, liver disorders, cardiac patients and patients who have undergone dialysis were excluded. Data analysis was done using the Z test. p-value < 0.05 was defined as significant.

3. Results

The age of the patients was 30-70 years. Comparison between the controls and cases (CRF) of RBS, creatinine, urea, sodium, pot assium, magnesium phosphorous, iron and calcium parameters have shown a statistically significant difference in all the parameters, p-value < 0.05 [Table 1].

A comparison of CRF subjects based on gender in persons undergoing dialysis has shown no statistically significant difference in all the parameters, p-value > 0.05 [Table 2].

Comparison of groups RBS, creatinine, urea, sodium, potassium, magnesium, phosphorus, iron and calcium parameters in CRF with hypertension versus CRF with both hypertension and DM cases have shown statistically no significant difference in all the parameters, p-value > 0.05 [Table 3].

The RBS, creatinine, urea, magnesium, phosphorous and potassium levels were significantly increased ($p < 0.05$) in Group B compared with Group A. The levels of calcium, iron and sodium were decreased significantly ($p < 0.05$) in Group B compared with Group A.

The RBS, magnesium, calcium, phosphorous, iron, and potassium were decreased in CRF patients with hypertension compared with CRF subjects with both hypertension and DM. Creatinine, urea and sodium were increased in CRF patients with hypertension compared with CRF subjects with both hypertension and DM and have shown no statistical significance, p-value > 0.05.

4. Discussion

One of the progressive diseases causing irreversible descend in the glomerular filtration rate further resulting in elevation of blood urea and serum creatinine levels is chronic renal failure.[11] The main reason for chronic renal failure is hypertension, diabetes mellitus, autoimmune cause,

Table 1: Comparison of biochemical variables between the controls and cases

Parameters	**Group A** **Mean ± SD**	**Group B** **Mean ± SD**
RBS (mg/dl)	84.9 ± 6.8	136.6 + 73.23 *
Creatinine (mg/dl)	0.64 ± 0.1	11.27 ±4.85 *
Urea (mg/dl)	32.2 ± 5.27	190.8 ± 72.47 *
Magnesium (mg/dl)	2.1 ± 0.25	3.06 ± 1.06 *
Calcium (mg/dl)	9.3 ± 0.48	7.57 ± 0.48*
Phosphorous (mg/dl)	2.8 ± 0.24	6.75 ± 2.58*
Iron (μ g/dL)	125.8 ± 28.99	44.33 ± 14.98 *
Sodium (mEq/L)	141.4 ± 2.4	132.53 ± 6.68 *
Potassium (mEq/L)	4.1 ± 0.2	4.82 ± 0.76 *

*Significant p-v alue < 0.05

Table 2: Comparison of biochemical variables in CRF subjects based on gender

Parameters	**Females (11)** Mean ± SD	**Males (19)** Mean ± SD	P Value > 0.05
AGE	47.6 ± 11.8	54.4 ± 12.38	NS
RBS(mg/dl)	158.9 ± 109.03	123.68 ± 39.42	NS
Creatinine (mg/dl)	12.3 ± 4.84	10.7 ± 4.89	NS
Urea(mg/dl)	197.1 ± 70.62	187.2 ± 75.19	NS
Magnesium (mg/dl)	2.73 ± 0.24	3.25 ± 1.3	NS
Calcium(mg/dl)	7.58 ± 0.9	8.05 ± 0.48	NS
Phosphorous (mg/dl)	7.65 ± 3.06	6.23 ± 2.17	NS
Iron(μg/dL)	40.8 ± 18.53	46.37 ± 12.59	NS
Sodium(mEq/L)	134.6 ± 8.05	131.3 ± 5.62	NS
Potassium (mEq/L)	4.96 ± 0.68	4.74 ± 0.8	NS

NS: Not Significant

Table 3: Comparison of biochemicalvariables in CRF patients with Hypertension and both Hypertension and DM cases

Parameters	**CRF with HTN (11)** Mean ± SD	**CRF with HTN + DM (13)** Mean ± SD	P Value > 0.05
RBS(mg/dl)	108.2 ± 16.36	162.8 ± 102.98	NS
Creatinine(mg/dl)	10.7 ± 4.38	9.92 ± 4.37	NS
Urea(mg/dl)	187.6 ± 61.49	169.5 ± 60.26	NS
Magnesium(mg/dl)	2.7 ± 0.44	3.4 ± 1.48	NS
Calcium(mg/dl)	7.75 ± 0.92	7.98 ± 0.43	NS
Phosphorous(mg/dl)	6.1 ± 2.23	7.57 ±3.09	NS
Iron(μg/dL)	42.2 ± 16.33	44.4 ± 16.11	NS
Sodium(mEq/L)	134.1 ± 5.2	130.1 ± 6.64	NS
Potassium(mEq/L)	4.5 ± 0.55	4.9 ± 0.83	NS

NS: Not Significant

etc. Reduced kidney function is associated with a variety of biochemical abnormalities which include serum electrolytes, calcium, and phosphorus levels.

In our study, we observed, the significant increase in the levels of serum glucose, creatinine, urea in Group B (p-value < 0.05), when compared with Group A. The same results were found in the studies conducted by other authors.[3,7,12] In the present study, there is significant increase in the levels of serum potassium, magnesium and phosphorous in Group B (p -value < 0.05), when compared with Group A. The same results were found in the studies conducted by various authors.[13]

Hyperkalemia in CRF is due to decreased renal excretion, may be because of leakage from the intracellular space and also due to an impaired thirst mechanism. Hypermagnesemia in chronic renal failure is due to decreased renal excretion of magnesium which is a precondition of impairment of renal function.[13] Increased levels of serum phosphorus in chronic renal failure compensate the loss of reservoir function of the skeleton.[14]

Serum sodium, calcium and iron levels were found significantly decreased (p - < 0.05) in Group B, when compared with Group A. Reduced serum sodium levels in CRF due to impaired regulation of dilution and concentration of kidneys.[15] Decreased calcium levels is due to decreased intestinal calcium absorption because of low plasma calcitriol (1,25 dihydroxy cholecalciferol) levels which are synthesized in the kidney from 25-OH cholecalciferol by the action of enzyme 1α hydroxylase. Decreased iron levels in advanced chronic renal failure are mainly due to decreased intake and reduced absorption from the intestine results in negative iron imbalance.[14] In chronic renal failure, anemia is commonly seen as erythropoietin (EPO) is not sufficiently produced due to kidney damage, which helps in the production of red blood cells from the bone marrow.

Serum urea and creatinine levels are increased in chronic renal failure patients, leading to various other dangerous diseases[12] like heart and blood vessel disease. In chronic renal failure, elevated serum phosphate, and decreased serum calcium is due to mineral bone disorder.[16]

In our study, we observed increase in the levels of serum calcium mean value 8.05 ± 0.48 (mg/dl) and decrease in serum potassium mean value 4.74 ± 0.8 (mEq/L), in male CRF subjects compared with female CRF subjects and has shown no statistical significance. The same results in the levels of serum calcium mean value 8.26 ± 1.18 (mg/dl) and decrease in serum potassium mean value 4.73 ± 1.04 (mEq/L) were found in the studies conducted by various authors.[17]

In our study, we observed elevated serum creatinine 10.7 ± 4.38 (mg/dl) in CRF patients with hypertension compared with CRF subjects with both hypertension and DM serum creatinine 9.92 ± 4.37 (mg/dl) and have shown no statistical significance. The same results were found in the studies conducted by various authors.[18]

5. Conclusion

This study is useful concerning CRF subjects where there is elevated serum phosphate, magnesium and decreased serum calcium, iron. The future scope of the study was to include serum phosphorous, magnesium, serum calcium and iron in renal profile.

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7. Disclosure Statement

The authors declare no conflict of interest in this study.

8. Ethical Consideration

This study was confined to the guiding principles of the Institutional Ethical Committee and was approved by the Institutional Ethical Committee of Alluri Sitarama Raju Academy of Medical Sciences (IEC approval number: IEC/ASR/APPROVAL/09/2019).

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