A Study of Serum Magnesium Level in Patients with Chronic Renal Failure at Tertiary Care Hospital

Hardik Patel[1], Vivek Redkar[2], Akshay Kulkarni[3], Akshay Kale[4]

ABSTRACT

Introduction: CKD represents a progressive irreversible decline in the glomerular filtration rate (GFR). A common phenomenon in renal failure is progressive renal function loss irrespective of the underlying cause of the kidney disease. Hypermagnesaemia is often associated with undetected renal impairment and excessive oral administration of magnesium containing drugs (e.g. laxatives or antacids) or with advanced CKD. The present study was conducted to assess serum magnesium levels in cases with chronic renal failure

Material and Methods: It was observational study carried out at Tertiary Institute to assess the levels of serum magnesium in chronic renal failure patients. A total of 80 patients were selected by simple random sampling with chronic renal failure.

Results: It was shown that majority of patients were male (58.75%). Majority of patients were having hypertension (60%) followed by diabetes mellitus (43.75%). The serum magnesium among patients showed that majority of patients presented with hypermagnesaemia and serum magnesium level was low in patients with dialysis.

Conclusion: Serum magnesium is a worthwhile tool in assessing duration of disease, morbidity and mortality in patients with chronic renal failure.

Keywords: Chronic Kidney Disease (CKD), Magnesium (Mg), Dialysis

INTRODUCTION

Chronic kidney disease (CKD) is a worldwide health problem, affecting millions of people.[1] CKD patient is any person who, regardless of cause has a GFR of < 60 mL/min/1.73 m^2 or a GFR of > 60 mL/min/1.73 m^2 plus at least one marker of renal parenchymal injury (e.g. proteinuria) present for at least ≥ 3 months.[2] Magnesium (Mg) is the fourth most abundant cation in the body and the second most important intracellular cation. In patients with chronic kidney disease (CKD) and end-stage renal disease (ESRD) changes in Mg homeostasis may occur. An understanding of the physiology in Mg handling is therefore of relevance for those taking care of patients with CKD and ESRD.[3] The kidney is crucial in the maintenance of normal serum Mg concentrations. The ability of excretion deteriorates when renal function declines.[3] In CKD stage 1–3, an increase in fractional Mg excretion compensates for the loss of renal function and as a consequence Mg levels are regulated within the normal range.[4] In advanced CKD stage 4–5, compensatory mechanisms become inadequate and the fraction of filtered Mg excreted increases as a result of the impaired tubular reabsorption. This becomes even more marked when the glomerular filtration rate falls below 10 mL/min. So, the compensatory rise in fractional Mg excretion is insufficient to prevent an increase in serum Mg concentration. Low serum magnesium levels are associated with vascular calcification and increased cardiovascular mortality in chronic kidney disease patients. On the other hand, hypermagnesaemia inhibits parathyroid hormone secretion which is considered an important risk factor for vascular calcification, left ventricular hypertrophy and mortality in chronic kidney disease.[5]

The present study was conducted to assess serum magnesium levels in cases with chronic renal failure and to detect a correlation if any of serum magnesium with clinical features and severity of impairment of renal function.

MATERIAL AND METHODS

The present study was observational study carried out at Tertiary Institute to assess the levels of serum magnesium in chronic renal failure patients. The study was conducted at Department of Medicine, Krishna Hospital, Karad. All patients who present to the hospital and admitted with chronic renal failure were included in the study. Based on the pilot study, the prevalence of CKD was taken as 5%.[6] Sample size was estimated at 5% level of significance with an allowable error of 10%, using the following formula.

$$n \frac{Z(1-\frac{\alpha}{2})2pq}{L^2}$$

Where: n = Sample size, Z=Standard Normal variate (at 5% type I error), p = Prevalence, q = (1-p), L=Allowable error

Hence, a minimum sample size of approximately 80 cases during study period was randomly selected and included in present study. This study was conducted during the period from October 2016 to March 2018. Patients who are above 18 years with serum creatinine above 2 mg% with Abnormal findings on renal ultrasound asymmetric kidney size, small kidney(<9cm) or large polycystic kidney and Increased

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serum creatinine with no improvement for >3 months and Uremic symptoms over 3 months with increased serum creatinine were included in this study. Patients with chronic renal failure with Diarrhea, Pancreatitis, on magnesium treatment and Age less than 18 years were excluded from study.

STATISTICAL ANALYSIS

The statistical analyses performed using the Statistical Package for Social Science (SPSS) version 21 for Windows. Data were expressed as mean values ± standard deviations (SD) for continuous variables. Frequency and proportions were reported for categorical variables. The p-value of < 0.05 was considered statistically significant.

RESULTS

The study revealed that the majority of patients were in age group >60 years followed by 51-60 years. (Figure 1) The distribution of patients according to sex showed that majority of patients were male (58.75%) and females were 41.25%. (Figure 2)

The distribution of patients according to co-morbidities showed that majority of patients were having hypertension followed by diabetes mellitus. (Figure 3) The majority of patients were in stage 5 (33.75%) followed by stage 4 (28.75%). The stage 3, stage 2 and stage 1 was observed in 23.75%, 10% and 3.75% patients. (Table 1) Patients presented with nausea (78.75%) followed by vomiting (67.5%). The other clinical presentation includes oliguria

Stage	No. of Patients	Percentage
1	03	03.75
2	08	10.00
3	19	23.75
4	23	28.75
5	27	33.75
Total	80	100

Table-1: Stage of CKD.

Clinical features	No. of Patients (n=80)	Percentage
Nausea	63	78.75
Vomiting	54	67.50
Fatigue and weakness	43	53.75
Fever	46	57.50
Oliguria	51	63.75
Confusion	29	36.25
Oedema	38	47.50
Others	16	20.00

Table-2: Distribution according to clinical features.

Magnesium levels (mg/dl)	No. of Patients	Percentage (%)
Hypo (<1.2)	01	01.25
Normal	30	37.50
Hyper (>4.8)	49	61.25
Total	80	100

Table-3: Distribution according to Serum magnesium levels.

Serum Magnesium	Correlation (r)	p value
Hemoglobin	0.24	0.05
Blood Urea	0.17	0.13
Serum Creatinine	0.81	<0.001
Serum Sodium	0.005	0.97
Serum Calcium	0.031	0.78
Serum Potassium	-0.022	0.84
Serum Phosphorus	-0.076	0.51

Table-4: Correlation of serum magnesium and other investigations.

Serum Magnesium levels	Before Hemodialysis	After Hemodialysis	P value
(Mean ±SD)	4.34± 1.38	2.67 ±0.98	<0.001

Table-5: Effect of dialysis on serum magnesium levels.

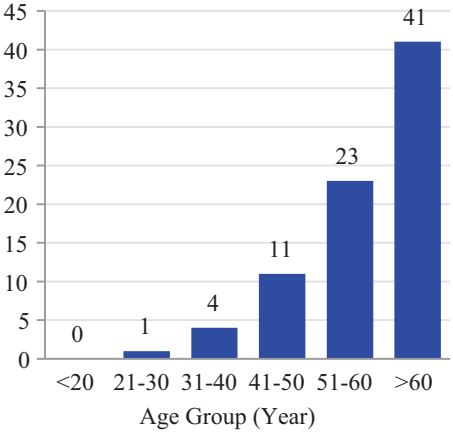

Figure-1: Distribution according to age.

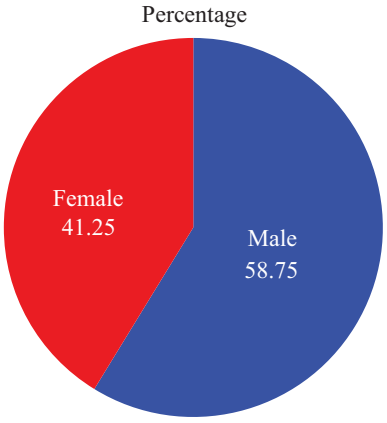

Figure-2: Distribution according to gender.

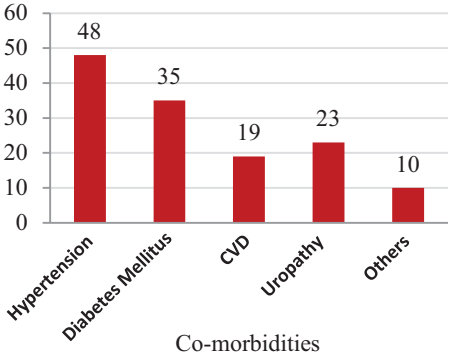

Figure-3: Co-morbidities

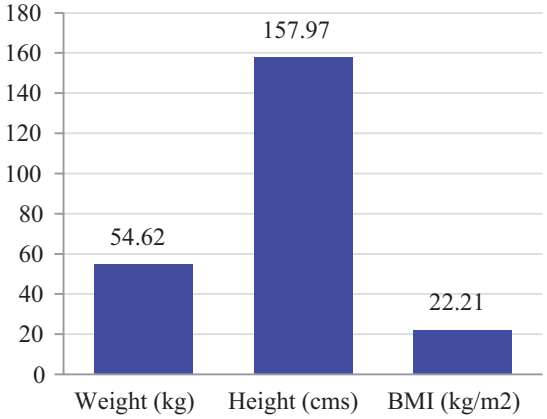

Figure-4: Anthropometric characteristics

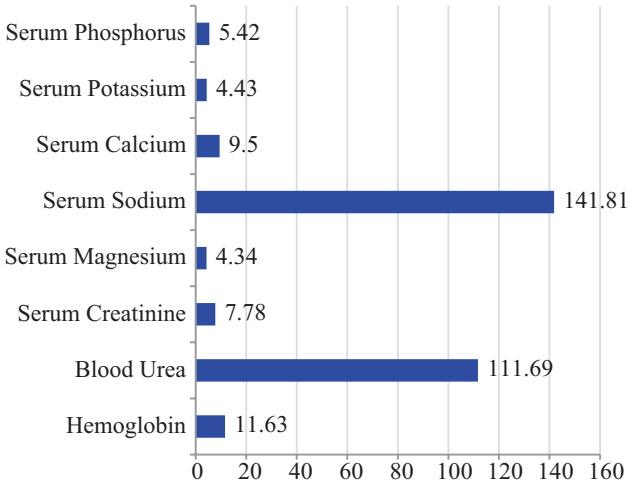

Figure-5: Distribution according to investigations.

(63.75%), fever (57.5%) and confusion (36.25%). (Table 2) The mean weight of the patients was 54.62 ±12.42 kg. The mean height of the patients was 157.97 ±06.67 cms while mean BMI of the patients was 22.21 ± 05.12 kg/m^2. (Figure 4)

The mean hemoglobin of the patients was 11.63 ±1.90. The mean blood urea of the patients was 111.69 ±16.59 while mean serum creatinine among patients was 7.78 ±2.98. The mean serum magnesium of the patients was 4.34 ±1.38 while serum sodium, serum calcium, serum potassium and serum phosphorus was 141.81±4.62, 9.50±0.61, 4.43±0.38 and 5.42 ±0.87 respectively. (Figure 5) The serum magnesium among patients showed that majority of patients presented with hyper magnesium (61.25%) followed by normal magnesium levels (37.50%). (Table 3) The correlation of serum magnesium and other parameters among patients showed that serum creatinine showed significant correlation with serum magnesium ($p<0.05$) while hemoglobin, blood urea, serum sodium, serum potassium and serum phosphorus showed no significant correlation ($p>0.05$). (Table 4) The correlation of serum magnesium and dialysis among patients shows serum magnesium before dialysis was more (4.34 ± 1.38) compared to after dialysis (2.67 ± 0.98) of patients with statistically significant correlation ($p<0.05$). (Table 5)

DISCUSSION

Electrolyte and metabolic disturbances and their biochemical role in disease and its symptoms opened a new chapter in disease patho-physiology and treatment. Magnesium is gaining the important status now as other electrolytes have been extensively studied. In the present study, it was observed that majority of patients were in age group >60 years (51.25%) followed by 51-60 years (28.75%). The mean age of the patients was 58.26 ±19.85 years. Similar findings were observed in a study done by Amit Naik et al[7] on study of serum magnesium level in Chronic kidney disease and its clinical correlation with other biochemical parameters where maximum 16 cases (32%) were from age group 51-60 years, while minimum i.e. 3 cases (6%) from age group 10-20 years of age. Ahmed H. Mitwalli et al[8] studied serum magnesium (Mg) levels in CRF patients and observed the mean age of all patients was 49.16 ±18.25 years. In the present study distribution of patients according to sex showed that majority of patients were male (58.75%) and females were 41.25%. In a study done by Amit Naik et al[7] on study of serum magnesium level in Chronic kidney disease observed 36 cases (72%) were males and 14 cases (28%) were females with male to female ratio was 2.57:1. The findings were in contrast in a study by Ahmed H. Mitwalli et al[8] on serum magnesium (Mg) levels in CRF patients observed out of 115 patients 54 were males and 61 were females. The distribution of patients according to co-morbidities showed that majority of patients were having hypertension (60%) followed by diabetes mellitus (43.75%) The uropathy was observed among 23 (28.75%) patients. Similar findings were observed in a study done by Amit Naik et al[7] on study of serum magnesium level in Chronic kidney disease and its clinical correlation with other biochemical parameters where etiology of CKD (n=50) includes nephrotic syndrome in 10(20%), hypertensive encephalopathy in 20(40%), diabetics nephropathy in 19(38%). and obstructive uropathy in 1(2%) cases. The distribution of patients according to stage of CKD showed that majority of patients were in stage 5 (33.75%) followed by stage 4 (28.75%). It was observed that majority of patients presented with nausea (78.75%) followed by vomiting (67.5%). The other clinical presentation includes oliguria (63.75%), fever (57.5%) and confusion (36.25%). The distribution of patients according to various investigations among CKD showed that the mean hemoglobin of the patients was 11.63 ±1.90. The mean blood urea of the patients was 111.69 ±16.59 while mean serum creatinine among patients was 7.78 ±2.98. The mean serum magnesium of the patients was 4.34 ±1.38 while serum sodium, serum calcium, serum potassium and serum phosphorus was 141.81±4.62, 9.50±0.61, 4.43±0.38 and 5.42 ±0.87 respectively. In a study done by Sharma SK et al[9] on serum magnesium levels in chronic renal failure observed the mean serum magnesium level was significantly higher (4.10 +/- 0.85 mg/dl) in the patients as compared to controls (2.40 +/- 0.14 mg/dl; p less than 0.001) and levels rise progressively with deterioration in renal function.

Significantly higher serum magnesium levels were observed in patients of chronic renal failure with encephalopathy than in those without. Similar findings were observed in a study done by Amit Naik et al[7] where the mean serum magnesium level of 3.61 mg/dl was observed. Mean blood urea, serum creatinine, sodium, potassium, calcium and magnesium level were 111.36 mg/d1, 7.02 mg/dl, 135.01 MEq/L, 4.93 MEq/L, 8.99 mg/dl and 2.75 mg/dl respectively in CKD cases. The serum magnesium among patients showed that majority of patients presented with hyper magnesium (61.25%) followed by normal magnesium levels (37.50%). The hypomagnesium level was observed only in one patient. In a study by Ahmed H. Mitwalli et al[8] on serum magnesium (Mg) levels in CRF patients observed 10 patients (8.7%) had Mg levels of <0.7 mmol/L while 26 (23.9%) showed levels of >1.1 mmol/L. In the present study, it was observed that serum magnesium before dialysis was more (4.34± 1.38) compared to after dialysis (2.67 ±0.98) of patients with statistically significant correlation ($p<0.05$). In a study done by Sharma SK et al[9] on serum magnesium levels in chronic renal failure observed the mean serum magnesium level fall was significantly higher in patients on dialysis as compared to non-dialysed patients. In a study by Ahmed H. Mitwalli et al[8] on serum magnesium (Mg) levels in CRF patients observed hypomagnesaemia in dialysis patients and leads to a number of symptoms, including anorexia, fatigue, and muscle weakness. In the present study, the correlation of serum magnesium and other parameters among patients showed that blood urea, serum ceratinine, serum calcium and serum potassium showed significant correlation with serum magnesium ($p<0.05$) while hemoglobin, serum sodium and serum phosphorus showed no significant correlation ($p>0.05$). Similar findings were observed in a study done by Amit Naik et al[7] on study of serum magnesium level in Chronic kidney disease and its clinical correlation with other biochemical parameters where CKD cases had positive correlation between serum magnesium and blood urea, creatinine and potassium while negative correlation between serum magnesium and serum sodium and calcium levels. Similar findings have been observed by various other authors. Hirschfelder and Haury[10] showed by animal experiments that injury to renal tubules is more important than injury to glomeruli for hypermagnesaemia of renal insufficiency. It is not possible to determine in the living human being whether tubules are more injured or glomeruli, but on the basis of above experiment it can be conjectured that renal tubules might be more injured than glomeruli in cases showing hypermagnesaemia. The same mechanism could also explain the conflicting reports of high and low serum magnesium in chronic renal diseases on the basis that in some cases tubules might be more injured than glomeruli and vice versa. Robinson et al[11] found that in renal disease cases when the glomerular filtration rate is less than 30 cc. per minute, there occurred definite hypermagnesaemia. Basic cause of high serum magnesium is related with low glomerular filtration rate and passive back diffusion though damaged tubule cells.

CONCLUSION

The serum magnesium among patients with chronic kidney disease had hyper magnesium. All patients suffering from CKD should be advised low magnesium in diet similar restriction to potassium to prevent CNS depression and Cardiac arrthymia. Serum magnesium is a worthwhile tool in assessing duration of disease, morbidity and mortality in patients with chronic renal failure. Its estimation may help in evaluating conservative treatment and dialysis in chronic renal failure.

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