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Original Research Article

Serum Magnesium as a Predictor of In-Hospital Mortality in Chronic Kidney Disease Patients.

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Abstract

Introduction: In the general population, hypomagnesemia has been associated with cardiovascular events and hypermagnesemia with overall mortality. In chronic kidney disease (CKD) the evidence is not so strong. The study's objectives were to learn about impact of serum magnesium level on in hospital mortality of patients with chronic kidney disease.

Methods: This is a single-center cross-sectional study of 100 patients admitted to the Medicine ICU at Shyam Shah Medical College and SGM Hospital Rewa between April 2021 and March 2022.

Results: Hypomagnesemia was present in 16% and Hypermagnesemia was present in 26% patients. Maximum patients belong to 40-60 years age group. In hospital mortality was high in both hypomagnesemia and hypermagnesemia patients.

Conclusion: In our study, we discovered that as stage of CKD increases, so does the level of Magnesium. Both hypomagnesemia and hypermagnesemia was associated with high in-hospital mortality.

Keywords: Magnesium, Chronic Kidney Disease, Mortality

1. INTRODUCTION:

Chronic kidney disease (CKD) is a global health issue that affects millions of individuals.[1] CKD patient is defined as anyone who, regardless of origin, has a GFR of 60 mL/min/1.73 m2 or above, as well as at least one marker of renal parenchymal injury (e.g., proteinuria) present for at least 3 months.[2]

The kidney regulates magnesium levels in the body through filtration and reabsorption. About 70-80% of plasma magnesium is filterable, with most reabsorbed in the tubules. The kidneys adjust their handling of magnesium in response to changes in plasma concentration, leading to increased excretion in hypermagnesemia and decreased excretion in hypomagnesemia. This regulation is necessary to maintain magnesium balance for physiological processes.[3]

Magnesium is a vital cation involved in numerous physiological processes, including bone and ATP metabolism, neurotransmitter release, blood vessel tone, and heart rhythm. Abnormal serum magnesium homeostasis is common in CKD patients. Early CKD can be managed by increasing fractional magnesium excretion, but as CKD progresses, tubular reabsorption decreases, causing hypomagnesemia. This emphasizes how crucial it is to comprehend magnesium.[4]

In CKD stages 4 and 5, decreased magnesium excretion can lead to low serum magnesium levels, linked to increased cardiovascular mortality. Hypermagnesemia can also lead to inhibited parathyroid hormone secretion, increasing the risk of vascular calcification and mortality in CKD patients. Thus, optimal magnesium balance is crucial in CKD to avoid adverse health effects from both low and high magnesium levels.[5]

2. MATERIAL AND METHOD

The study conducted at Shyam Shah Medical College and Sanjay Gandhi Memorial Hospital in Rewa from April 2021 to March 2022. It was a 12-month cross-sectional study approved by the institutional ethics committee, and all participants provided voluntary consent.

Sample size: 100 patients

Aims and objective:

1. Relationship between serum magnesium level and in hospital mortality in CKD patients
2. Clinical and demographic profile of CKD patients

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3. To know the relation of serum magnesium with different stages of chronic kidney disease patients

Inclusion criteria:

CKD Patients

Exclusion criteria:

Patients with

1) Presenting complaints of Diarrhea, Pancreatitis, and vomiting.
2) Patients on diuretics
3) Patients on steroids.
4) Patients with shock
5) Patients with urological causes.
6) Age less than 18 years.

Methodology

Following informed consent, patients were subjected to a battery of laboratory testing, including renal function tests, serum magnesium, calcium, sodium, and potassium levels, complete blood counts, and urine routine and microscopy. A renal ultrasound was also conducted. Patients were diagnosed with CKD based on the results of these tests, and their eGFR was computed using the MDRD formula. Following that, patients were divided into their separate CKD stages, and the relationship between serum magnesium levels and mortality in CKD patients was investigated.

3. RESULTS:

Table No 1: Relation Between Serum Magnesium Level and In Hospital Mortality

OUTCOME	**Group 1 <1.5 mg/dL**	**Group 2 1.5 – 2.3 mg/dL**	**Group 3 >2.3 mg/dL**	**P value**
SURVIVED (N= 77)	14(8.75%)	53(91.37%)	10(38.46%)	**<0.00001**
DEATH (N=23)	2(12.5%)	5(8.6%)	16(61.53%)	
TOTAL (N=100)	16%	58%	26%	

Table 1 shows that mortality was higher in both hypomagnesemia and hypermagnesemia patients.

Table No-2: Age and Sex Distribution Among CKD patients

Age Group (Yrs.)	**Total no of cases (n=100)**	**% Of no. of cases**	**Male (n=58)**	**% Of males**	**Female (n=42)**	**% Of females**
18-20	04	4.0	04	100.0	0	0.0
21-30	10	10.0	08	80.0	02	20.0
31-40	20	20.0	12	60.0	08	40.0
41-50	20	20.0	14	70.0	06	30.0

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51-60	22	22.0	12	54.55	10	45.45
61-70	18	18.0	10	55.56	08	44.44
>70	06	6.0	04	66.66	02	33.34
Total	**100**	**100%**	**58**	**58.0**	**42**	**42.0**

Table 2 shows the demographics of 100 CKD patients, with 58 (58%) being male and 42 (42%) females. The most common age group was 51-60 years, accounting for 22% of the total patients. The Male: Female in the study was 1.38:1.

Table no 3: Distribution of patients CKD according to CKD staging.

CKD stage	**No. of patients**	**Percentage**
1	3	3.0
2	16	16.0
3	40	40.0
4	35	35.0
5	6	6.0

Table no 3 displays the distribution of patients among different stages of CKD, where 6 patients were categorized as stage 5, 35 patients as stage 4, 40 patients as stage 3, 16 patients as stage 2, and patients as stage 1

Table no 4: Correlation Between CKD Stages and Serum Magnesium

CKD stage	**Serum Magnesium levels**(mg/dl)	**p value**
1	2.10± 0.20	t= 9.55, p<0.0001
2	2.10± 0.28	t= 17.1, p<0.0001
3	2.74± 0.50	t= 13.3, p<0.0001
4	3.95± 0.54	t= 12.0, p<0.0001
5	4.66± 0.43	t= 23.3, p<0.0041

Table 4 shows mean serum magnesium levels across CKD stages: stage 5=4.66±0.43, stage 4=3.95±0.54, stage 3=2.74±0.50, stage 2 and 1=2.10±0.28 and 0.20 mg/dl, respectively.

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Table no 5: Relationship Between Mean Serum Magnesium Levels in Patients with Encephalopathy in CKD Patients

Group	**Serum Magnesium levels(mg/dl)**
With encephalopathy	4.55±1.11
Without encephalopathy	3.04±0.81
p value	0.0009

Table no 5 presents the mean serum magnesium levels among CKD patients, where the mean serum magnesium level in patients with encephalopathy was 4.55±1.11 mg/dl and the mean serum magnesium level in patients without encephalopathy was 3.04±0.81 mg/dl.

Table no 6: Mean value of various parameters in CKD patients.

Parameter	**Mean value**
Age (years)	47.52±14.02
eGFR (ml/min/1,73 m2)	40.92±21.35
Blood Urea (mg/dl)	102±52.21
Serum Creatinine (mg/dl)	1.96±0.88
Serum Sodium (meq/l)	137.1± 2.16
Serum potassium (meq/l)	4.65 ± 0.96

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Serum calcium (mg/dl)	9.15±0.61
Serum Magnesium (mg/dl)	3.16±0.93
BMI (kg/m^2)	22.1±3.77

Table no 6 displays the following mean values for CKD patients: age of 47.52±14.02 years, eGFR of 40.92±21.35 ml/min, blood urea levels of 102±52.21 mg/dl, serum creatinine levels of 1.96±0.88 mg/dl, serum sodium levels of 137.1±2.16 meq/l, serum potassium levels of 4.65±0.96 meq/l, serum calcium levels of 9.15±0.61 mg/dl, serum magnesium levels of 3.16±0.93 mg/dl, and BMI of 22.1±3.77 kg/m2.

4. DISCUSSION:

In our study **(Table 1**) hypomagnesemia and hypermagnesemia was significantly associated with mortality in CKD patients. Study conducted by **Corillo IG** et al [7] found similar results that patients with hypermagnesemia had a higher risk of all-cause mortality (Log Rank 13.11, p<0.001), while there was no association between hypomagnesemia and all-cause mortality (p=0.743)

In our study of 100 CKD patients, 58 (58%) were male, and 42 (42%) were female, with a male to female ratio of 1.38:1. The most common age range was 51-60 years, comprising 22% of the total patients. The largest number of male patients were in the 41-50 age group, and the largest number of female patients were in the 51-60 age group.

Patel H et al.[8] observed that a significant portion of their patient population fell within the age group of >60 years (51.25%) and 51-60 years (28.75%). Our study found that most patients were male (58.75%) with a mean age of 58.26 ±19.85 years. **Naik A et al.**[9] reported that the highest number of cases (32%) were between the age of 51-60 years, with male to female ratio of 2.57:1. The lowest number of cases (6%) were observed in patients aged 10-20 years.

Mitwalli AH [10] found that out of 115 patients, 54 were male and 61 were female. In **Jadhav NN et al**[11] male patients were 58.75% and females were 41.25%.

In our study **(Table3**), 6 patients had stage 5 CKD, 35 patients had stage 4, 40 patients had stage 3, 16 patients had stage 2, and 3 patients had stage 1. **Patel H et al.**[8] found that stage 5 was the most common stage (33.75%), followed by stage 4 (28.75%). Stage 3, 2, and 1 were observed in 23.75%, 10%, and 3.75% of patients, respectively. **Jadhav NN et al.**[11] reported a predominance of stage 5 (85%), followed by stage 4 (12.50%), with only 2.50% of patients in stage 3.

Table no 4 shows that there is a positive correlation between the stage of CKD and serum magnesium levels, which suggests that as the stage of CKD advances, the serum magnesium levels also increase. This means that as the eGFR of CKD patients decreases, their serum magnesium levels increase. This observation is consistent with a previous study by **M de Francisco AL et al** [12], which found that in moderate CKD (stage 1-3), loss of renal function is compensated by an increased fractional excretion of magnesium, but this mechanism fails in advanced CKD, resulting in hypermagnesemia.

Table 5 indicates that mean serum magnesium levels were higher in CKD patients with encephalopathy (4.55±1.11 mg/dl) than those without (3.04±0.81 mg/dl). Similar findings were reported in previous studies by **Patel H et al.** [8], **Jadhav NN et al.**[11], and **Sharma SK et al.**[13]**. Jadhav NN et al.**[11] reported a mean serum magnesium value of 5.28±0.44 in patients with encephalopathy, compared to 3.93±1.45 in those without**.**

In our study **(Table 6)** the mean age of CKD patients was 47.52±14.02 years, and the mean eGFR was 40.92±21.35 ml/min. The mean levels of blood urea, serum creatinine, serum sodium, serum potassium, serum calcium, serum magnesium, and BMI were 102 mg/dl, 1.96 mg/dl, 137.1 meq/L, 4.65 meq/L, 9.15 mg/dl, 3.16 mg/dl, and 22.1 kg/m2, respectively.

Compared to **Patel H et al.**[8], the mean age of their patients was higher at 58.26±19.85 years. In **Jadhav NN et al** [11], their patients had higher mean levels of blood urea, serum creatinine, serum sodium, serum potassium, serum calcium, serum magnesium, and BMI, which were 111.69±16.59 mg/dl, 7.78±2.98 mg/dl, 141.81±4.62 meq/L, 4.43±0.38 meq/L, 9.50±0.61 mg/dl, 4.34±1.38 mg/dl, and 22.21±05.12 kg/m2, respectively**. Patel H et**

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al.[8] reported similar mean levels of blood urea, serum creatinine, serum sodium, serum potassium, serum calcium, serum magnesium, and BMI as **Jadhav NN et al** [11].
Meanwhile, **Naik A et al.**[9] reported lower mean levels of blood urea, serum creatinine, serum sodium, serum potassium, serum calcium, serum magnesium, and BMI, which were 111.36 mg/dl, 7.02 mg/dl, 135.01 meq/L, 4.93 meq/L, 8.99 mg/dl, and 2.75 kg/m2, respectively.

5. CONCLUSION

To summarize, the study found that 16% of patients had hypomagnesemia and 26% had hypermagnesemia. Additionally, there was a significant association between serum magnesium levels and the stage of chronic kidney disease (CKD), where higher stages of the disease were linked with higher levels of serum magnesium. Furthermore, in-hospital mortality rates were found to be high for both hypomagnesemia and hypermagnesemia patients.

LIMITATION OF STUDY: single centered study and small sample size.
RECOMMENDATIONS: The study demonstrated a significant correlation between CKD stages and serum magnesium levels, indicating the potential importance of monitoring magnesium levels in managing CKD. However, larger sample size studies are required to better understand the clinical implications. Therefore, it is crucial to monitor serum magnesium levels regularly in patients with CKD.
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