

Correlation of Serum and Urinary Magnesium with eGFR in Chronic Kidney Disease Patients

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Abstract:

Aim And Objectives: The aim of our study is to correlate eGFR with serum and urinary magnesium levels in CKD patients.

Material And Methods: This study is a prospective study with total of 30 CKD patients (stages II-V) admitted in nephrology ward, males (n=21) and females (n=9), with mean age of 62.37 ± 12.41 years. Serum urea, creatinine, magnesium and spot urine magnesium were estimated. eGFR was calculated by MDRD 4 variable equation. Pearson's correlation done. P value of <0.05 is taken as significant.

Results: In patients with CKD the Mean \pm SD of serum urea (mg/dl), creatinine (mg/dl) and magnesium (μ mol/L) were 62.43 ± 37.57 , 4.35 ± 3.5 , 0.92 ± 0.38 respectively. The mean \pm SD of urinary magnesium and eGFR (ml/min/1.73m²) were 2.2 ± 1.44 , 30.73 ± 25.5 respectively. A significant negative correlation was observed between eGFR and serum and urinary magnesium ($r = -0.34$, $p = 0.06$, $r = -0.55$, p value < 0.002) respectively.

Conclusion: Our study shows increased magnesium levels in patients with high creatinine and low eGFR. Although serum magnesium levels are raised in higher stages of CKD but they are maintained within the normal range, this might be due to compensatory mechanisms adapted by the kidney. This may be attributed to deterioration in renal function leading to decreased excretion of magnesium and cannot be compensated any longer by increased fractional excretion of magnesium. However urinary magnesium showed stagewise increased excretion. More clinical research is needed to confirm and to understand.

I. Introduction

In healthy people, intestinal magnesium absorption and renal excretion are regulated so as to maintain magnesium balance [1]. The fractional absorption of magnesium (mainly in small intestine) adapts to dietary intake. Under normal conditions, ~30–50% of ingested magnesium is absorbed. However, the fractional absorption of magnesium rises to 80% if intake falls to ~25% when magnesium intake is high [2,3]. Experiments conducted in 8 volunteers who were given magnesium supplements with meals showed that as dietary magnesium increased from 1.5 mmol to 40 mmol the fraction of dietary magnesium absorbed fell progressively from 65 to 11% [4]. The kidney has a vital role in magnesium homeostasis, regulation of magnesium excretion is determined by filtration and reabsorption. In healthy subjects with normal renal function, approximately 74–100 mmol of magnesium are filtered everyday [5,6]. About 70–80% of plasma magnesium is ultra-filterable and ~95% of the filtered magnesium load is subject to tubular reabsorption with 5% excreted in urine [3]. The renal handling of magnesium depends to a great extent on the plasma magnesium concentration: in hypermagnesaemia, the fractional excretion of magnesium is high, and during hypomagnesaemia, it is low [3]. The regulation and elimination of magnesium in patients with renal disease is somewhat understudied. Despite this incomplete understanding, we know that serum magnesium levels increase when the glomerular filtration rate (GFR) falls below ~20–30 mL/min, yet we do not know what happens to serum magnesium concentration in patients with more modest falls in GFR [e.g. chronic kidney disease (CKD) Stages 1–3; GFR > 30 mL/min] or what proportion of these patients are likely to be hypermagnesemic. In addition, we also need to consider the relationship between serum magnesium levels and urinary magnesium.

II. Material And Methods:

Patients for this study are recruited from the inpatient ward of nephrology department Nizam's institute of medical sciences. All the subjects were diagnosed as CKD patients, previously by clinical, biochemical and histopathological characteristics. Exclusion criteria were age below 18 yrs, systemic autoimmune disease, chronic hepatic disease. Creatinine measured by kinetic Jaffe's method. Urine and serum magnesium measured by xylylidyl blue method urine magnesium measured in spot urine sample. eGFR calculated for all the patients using MDRD 4 variable equation using age, race and serum Creatinine.

III. Results

Our study enrolled 30 patients which included various stages of CKD. Based on eGFR maximum number of people i.e. 43% falls in stage 5 and 27%, 17% and 13% in stage 3, stage 4 & stage 2 respectively (Fig.1).

The Mean±SD values of serum urea (mg/dl), creatinine(mg/dl) and magnesium(μmol/L) were 62.43±37.57, 4.35±3.5, 0.92±0.38 respectively. The mean±SDsof urinary magnesium(μmol/L) is 2.2± 1.44. Table.1 shows mean values urea, Creatinine and eGFRstagewise whereas magnesium levels were shown in Fig.2. Serum magnesium and urinary magnesium with eGFR,we found both the parameters are negatively correlated but the significant difference found with urinary magnesium(p=0.001)(Table.2). Although serum magnesium levels are raised in higher stages of CKD but they are maintained within the normal range,this might be due to compensatory mechanisms adapted by the kidney.

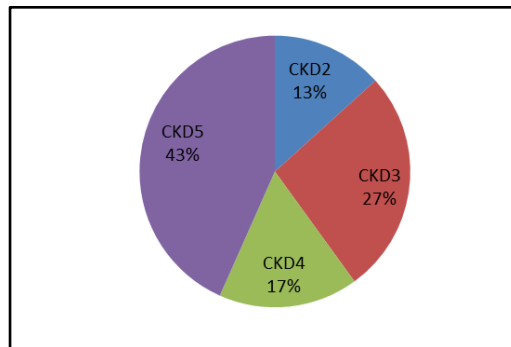


Figure1:Stagewise distribution of CKD patients.

Table 1:Descriptive statistics.

STAGE	CKD2	CKD3	CKD4	CKD5
N	4	8	5	13
Age(yrs) mean	69	58	64	59
Sr.Urea(mg/dl) mean	31.0	37.25	43.30	102.0
Sr.Creatinine(mg/dl)mean	1.08	1.80	2.90	10.40
eGFR(ml/min/1.73m ²)mean	75	43.4	29.3	5.5

Table 2:Correlation between Magnesium and eGFR

PARAMETER	eGFR	
	R value	P value
Serum Magnesium	-0.34	0.066
Urine Magnesium	-0.55	0.0016

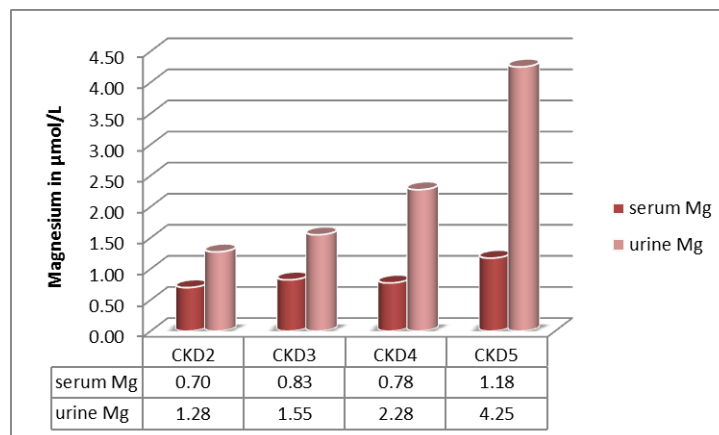


Fig 2: Mean values of serum and spot urine Magnesium values in CKD stages.

IV. Discussion

The gastrointestinal tract, the skeleton, and the kidneys are integrally involved in normal magnesium homeostasis. Gastrointestinal absorption is not highly regulated, and the kidneys play the primary role in maintaining magnesium balance. Bone plays an important role as a buffer, providing a large rapidly exchangeable pool to protect against acute changes in serum concentrations, although this has not been as well studied as in calcium regulation. The role of magnesium in bone mineralization and in the pathogenesis of renal disease has been a matter of some debate in recent years and a hypothesis has been advanced in the past to the effect that magnesium is directly involved in the development of osteomalacia and/or renal osteodystrophy [3,7,8,9&10]. Another group found elevated magnesium concentrations in trabecular and cortical bones, at the same time as lowered calcium and increased phosphorous concentration[11]. In contrast, other investigators

found increases in both calcium and magnesium content [12] and yet others found an increase in magnesium in both cortical and trabecular bones by 50-66% (wet and dry weight, respectively) and no difference in calcium concentrations [13]. The understanding of normal magnesium physiology has been greatly increased by the discovery of mutations in specific magnesium transporters, most of which lead to decreased gastrointestinal magnesium absorption or kidney magnesium wasting. Hence, most clinical disorders of magnesium are due to magnesium deficiency and are predominately due to gastrointestinal or kidney losses. These disorders can be either hereditary or acquired. Chronic kidney disease (CKD), and especially end-stage kidney disease is the only clinical disorder that has the potential to cause sustained hypermagnesemia and net positive magnesium balance. Only about 1-2% of total body magnesium is present in the extracellular fluid of which about 20% is protein bound. The principal stores of the body's 21-28 g of magnesium are bone (67%) and muscle (20%). Due to the distribution of magnesium and the fact that intracellular magnesium may not be readily exchangeable, serum concentrations do not adequately reflect total body stores.

Because the renal excretion of magnesium is so powerfully adaptable, impairment of renal function has long been recognized as a frequent prerequisite for the development of hypermagnesemia. However, in moderate CKD, the increase in the fractional excretion of magnesium compensates for the loss of renal function, such that serum levels are maintained within the normal range. This supports our study which shows that although serum magnesium levels are raised in higher stages of CKD but they are maintained within the normal range, this might be due to compensatory mechanisms adapted by the kidney. However, like all predominately intracellular ions, the serum magnesium concentration does not necessarily reflect total body balance. Hence estimating the urinary magnesium will give better overview of the magnesium status in patients of CKD.

V. Conclusion

Our study shows increased magnesium levels in patients with high creatinine and low eGFR levels. Although serum magnesium levels are raised in higher stages of CKD but they are maintained within the normal range, this might be due to compensatory mechanisms adapted by the kidney. This may be attributed to deterioration in renal function leading to decreased excretion of magnesium and cannot be compensated any longer by increased fractional excretion of magnesium. However urinary magnesium showed stage wise increased excretion. Hence estimating the urinary magnesium will give better overview of the magnesium status in patients of CKD. More clinical research with larger sample size is needed to confirm and to understand.

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