Serum Magnesium Level in Patients With Chronic Renal Failure

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ABSTRACT

Chronic kidney disease (CKD) is an overall medical issue, influencing a huge number of people. Magnesium (Mg ++) is the fourth most abundant and second most important intracellular extract in the body. In patients with CKD and end stage renal disease (ESRD), Mg ++ homeostasis may change. The present study is to assess the levels of serum magnesium in chronic kidney disease patients. The current cross-sectional study was performed to assess serum magnesium levels in cases with CKD and to detect the correlation of serum magnesium with clinical features and severity of renal impairment. The serum magnesium among patients with CKD had hyper magnesium. The serum magnesium level rises as kidney function deteriorates. There is significant fall in serum magnesium level after dialysis. Its estimation helps in evaluating conservative treatment and dialysis in CKD. Hence early evaluation and treatment of underlying cause for CKD is necessary to prevent further complication and kidney damage.

Keywords: Renal, Chronic kidney disease, Serum Magnesium, glomerular

INTRODUCTION

Chronic kidney desease (CKD) is an overall medical issue, influencing a huge number of people.[1] The issue is ineffectively depicted by the quantity of individuals that will start renal substitution treatment, as the frequency of 1-3 for every 10,000 every year in everybody may appear small.[2,3] However, interminable dialysis treatment and transplantation enormously affect the life of individual patients and their families, renal replacement treatment is very expensive.[4]

Magnesium (Mg ++) is the fourth most abundant and second most important intracellular extract in the body. In patients with CKD and end stage renal disease (ESRD), Mg ++ homeostasis may change. An understanding of physiology in Mg ++ handling is relevant to those who have a relationship with CKD and ESRD patients.[5]

Hence, the present study was done to assess serum magnesium levels in patients with CKD and to detect a correlation of serum magnesium with clinical features and severity of impairment of renal function.

AIM AND OBJECTIVES

Aim of the Study

To detect correlation of serum magnesium with clinical features and severity of renal impairment

Objectives of the Study

To assess the levels of serum magnesium in chronic kidney disease patients. To find effect of Hemodialysis on serum magnesium level. To find whether serum magnesium can be used as a marker to predict morbidity in chronic kidney disease.

REVIEW OF LITERATURE

Clinical and epidemiological reports provided a relationship between numerous factors and the initiation, progression of CKD. These are grouped into two well defined classes.

1. Risk factors: those that cause the CKD.

2. Risk markers: those are associated with CKD in absence of established causal relations.

Progressive glomerulopathies are among kidney diseases which cause rapid permanent loss of renal function. Most kidney diseases progress slowly over ten to fifteen years, initially without symptoms. This makes very difficult to identify the etiology. Indications are that environmental and lifestyle factors affect kidney function even though genetic factors also show some relevance.[6] Generally, kidney function reduces with age even among healthy subjects; this reduction or decline however is not similar but exhibits considerable individual variation.[7]

All kidney diseases progress to terminal renal failure relatively independent of the initial disease. Diabetic nephropathy, chronic glomerular diseases and hypertensive nephrosclerosis are among the most widespresd causes of CKD.[8] A primary disease eventually leads to secondary glomerular injury and nephron loss that is clinically characterized by proteinuria and hypertension, which leads to inflammation and/or scarring which causes kidney failure

and ultimately a gradual elevation in the plasma creatinine concentration and a progressive decline in GFR.[9] Apparently, the excessive protein filtration, which is caused by the glomerular hypertension, might per se have toxic effects on the kidneys and increase the rate of progression.[10,11] Studies in rats, have suggests that hyperfiltration and glomerular hypertension may play important roles.[12] Hyperfiltration is observed in diabetes and obesity, but also in any condition associated with a reduced number of nephrons.[13] To compensate for this nephron loss, the glomerular plasma flow rate and glomerular hydrostatic pressure increase in the surviving nephrons, thus raising the single nephron glomerular filtration rate. Initially, these changes are adaptive because they maintain the overall GFR. The central mediator of this observed glomerular haemodynamic changes seems to be angiotensin II, but it also controls other factors that might be of importance in the progression of kidney disease, such as the production of reactive oxygen species, the regulation of cytokines and profibrotic growth factors among others. Inappropriate activation of the other systems such as the sympathetic system, the endothelin system and of aldosterone has also been implicated in the progression of CKD.[14]

HYPERTENSION

There is compelling evidence from the epidemiological studies that hypertension causes a decline in renal function[15,16,17] and increases risks of ESKD.[18,19] However, some investigators have questioned whether non- malignant hypertension (in contrast to malignant hypertension) is an important initiator of kidney disease.[20,21] Although evidence that hypertension accelerates the progression of already existing renal failure is overwhelming, there is lack of data from clinical trials that aggressive treatment of hypertension reduces risk of kidney disease onset.

DIABETES

Diabetes contributes substantially to the burden of ESKD[22,23] thus the rapidly rising trend in type 2 diabetes prevalence throughout the world is of major concern.[24] There are indications that genetic susceptibility to nephropathy development may be in both type 1 and type 2 diabetes, although gene hunting studies have been unable to identify any particular mutations which could explain why diabetic nephropathy is mostly associated with diabetic patients.[25] Changing environmental or behavioural factors appear to be of importance for the development of diabetic nephropathy beside the genetic factors. Among Pima Indians where both type 2 diabetes and diabetic nephropathy are highly prevalent, the incidence rate of proteinuria among type 2 diabetics has doubled during the last four decades, notwithstanding improvements in plasma glucose levels and blood pressure.[26]

TOBACCO

Tobacco belongs to the Nicotiana species. It has been used by indigenous Americans for medicinal and ceremonial purposes for many years. Early in the 20th century the habit of using tobacco as a stimulant became widespread.[27] Tobacco smoking is the most identifiable cause of adult death in the developed countries, with the exception of hypertension. In recent decades a growing body of literature has emerged, supporting the idea that smoking is associated with adverse effects on the kidneys. Evidence suggests that smoking has a effect on kidneys in diabetics and in individuals with hypertension and pre- existing renal disease. Smoking may also cause renal damage in healthy individuals, which is independent of other factors according to experimental studies and population based epidemiological studies. Smoking in diabetes has been linked to increased risks of microalbuminuria development, accelerated progression from microalbuminuria to proteinuria and accelerated progression of manifest renal failure.[28]

PROTEIN INTAKE

A more than sixty years ago it was suggested that low protein diet (LPD) could preserve renal function in a patient with CKD.[29] Addis hypothesized that a LPD would reduce the workload of surviving nephrons in diseased kidneys and thus minimizes further loss of renal function. Brenner et al (1982) extended this view and postulated the hyperfiltration theory based on animal studies. He suggested that sustained excess of dietary protein cause increases in renal blood flow and glomerular filtration rate that lead to intrarenal hypertension, ultimately resulting in progressive sclerosis and deterioration of renal function. Whether or not an excessive protein intake can be detrimental in subjects without kidney disease has not been thoroughly evaluated.[12]

OBESITY

Obesity, a component of the metabolic syndrome, has become a key worldwide problem. Although this phenomenon may result from altered dietary patterns and a sedentary lifestyle among people in developed countries, which is rapidly emerging problem in developing countries. Worldwide obesity has increased 3-fold since 1980 and according to reports from the World Health Organization (W.H.O.), over one billion adults are overweight (body mass index [BMI] ≥25 kg/m2) with at least 300 million being obese (BMI ≥ 30 kg/m2).[30] There are further, great concerns about the rising prevalence of overweight and obesity among adolescents and children of school going age. Obesity contributes significantly to the burden of diseases such as cardiovascular disease, cancers, type 2 diabetes and hypertension among others.[31]

ANALGESICS

A more than fifty years ago,[32] observed an association between chronic interstitial nephritis and excessive consumption of combination analgesics containing phenacetin. Soon thereafter reports of an increased occurrence of renal papillary necrosis among heavy users of phenacetin started appearing.[33] This nephropathy associated with analgesic use was initially called phenacetin nephropathy. It was later renamed analgesic associated nephropathy (AAN) since a lot of analgesics came under suspicion of causing nephropathy. During the last two decades results from epidemiological studies suggested that

analgesics do not only cause classical AAN but may also increase the risk of CKD and ESKD in general. Moreover, there are indications that analgesic use may exacerbate pre-existing CKD. The mechanisms involved in analgesic induced renal injury remains unclear but cell injury, free radical formation, prostaglandin inhibition, reduced medullary blood flow and possibly an immunological mechanism are suggested modes of actions.[34] Prostaglandin inhibition by aspirin and other NSAIDs causes redistribution of renal blood flow from renal medulla to renal cortex potentially resulting in the medullary ischaemia and eventual necrosis of renal papillae.[35]

DYSLIPIDAEMIA

Renal disease, in early as well as well as advanced stages, associated with abnormalities in lipoprotein metabolism. Dyslipidaemia appears to be independently associated with increased progression rate of CKD in patients with kidney disease,[36] and with increased risk of graft loss after renal transplantation. Moreover, there are indications that dyslipidaemia might initiate kidney disease. Two cohort studies in the general population reported links between elevated plasma triglycerides, high total serum cholesterol, and low high density lipoprotein cholesterol on the one hand and increases in serum creatinine at follow up on the other.[37]

GENETIC SUSCEPTIBILITY

There are indications that a generalized genetic susceptibility contributes to the development of ESKD.[38] The observation that there is a clear familial aggregation of ESKD due to diabetes, hypertension and glomerulonephritis, initiated the search for specific "candidate genes" that might be involved in renal diseases. Some specific mutations are suggested to increase the susceptibility for glomerular damage, and are implicated in the aetiology of focal segmental nephrosclerosis.[39] Studies using genome scan approach, which has the potential for a more comprehensive evaluation of inheritance throughout the genome and to locate previously unknown genes related to diseases, recently found evidence of susceptibility loci for diabetic nephropathy.[40]

MATERIAL AND METHODS

The present study was a descriptive cross-sectional non-traditional observational study conducted at a tertiary institution to assess serum magnesium levels in patients with chronic kidney disease. A minimum sample size of approximately 80 cases during study period was randomly selected and included in present study. The study was performed between October 2016 and March 2018. The study was done in the ICU of Ward and Department of Medicine, Krishna Hospital and Medical Research Center, Karad.

OBSERVATION AND RESULTS

Table 1: Distribution according to gender

Gender	n=80	%
Male	47	58.75
Female	33	41.25

Distribution of patients with gender shows predominance of males (58.75%) while females were 41.25%. There was significant statistical difference of gender. (chi square: 4.9; DF: 1; p= 0.027). (Table 1)

Table 2: Distribution according to stage of CKD

Stages of CKD	n=80	%
3	02	02.50
4	10	12.50
5	68	85.00

Frequency of patients in different stage of CKD showed predominance of patients in stage 5 (85%) followed by stage 4 (12.50%). The stage 3 was observed in only 2.50% patients. There was no patient with stage 1 and 2 CKD observed in present study. It was significant statistical difference of patients with stage of CKD. (DF: 2; p<0.0001). (Table 2)

Table 3: Anthropometric characteristics

Anthropometry	Mean	±SD
Weight (kg)	54.62	12.42
Height (cms)	157.97	06.67
BMI (kg/m^2)	22.21	05.12

Anthropometric distribution of patients shows the mean weight of patients was 54.62 (±12.42) kg. The mean height of patients in present study was 157.97 (±06.67) cms while mean BMI of the patients was 22.21 (±05.12) kg/m2. (Table 3)

Table 4: Laboratory parameters in study population

Investigations	Mean	±SD
Hemoglobin (g/dl)	11.63	1.90

Blood Urea (mg/dl)	111.69	16.59
Serum Creatinine (mg/dl)	7.78	2.98
Serum Magnesium (mg/dl)	4.34	1.38
Serum Sodium (mEq/L)	141.81	4.62
Serum Calcium (mg/dl)	9.50	0.61
Serum Potassium (mEq/L)	4.43	0.38
Serum Phosphorus (mg/dl)	5.42	0.87

The mean hemoglobin of patients was 11.63 (±1.90). The mean blood urea of patients was 111.69 (±16.59) while mean serum creatinine among patients was 7.78 (±2.98). The mean serum magnesium 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.(Table 4)

Table 5: Distribution of Serum Magnesium according to stage of CKD

Stage of CKD	n=80	Serum Magnesium (mg/dl)	
		Mean	±SD
3	02	1.15	0.07
4	10	3.42	0.52
5	68	4.71	1.12

Serum magnesium levels in different stage of CKD shows the mean serum magnesium level increases with progression of CKD. This was in stage 3, 4 and 5 CKD was 1.15 (±0.07), 3.42 (±0.52) and 4.71 (±1.12) respectively.(Table 5)

Table 6: Distribution of patients according to dialysis

	n=80		
Dialysis	New (n=55)	Old (n=25)	%
Present (n=69)	44	25	86.25
Absent (n=11)	11	00	13.75

In present study majority patients (55) were not on dialysis on admission and 25 patients were on dialysis (old patients). Among 55 patients who were not on dialysis (newly diagnosed) total 44 patient required dialysis hence total 69 patients were on dialysis in present study. (Table 6)

DISCUSSION

Magnesium is now gaining critical status for electrolyte and metabolic disturbances as other electrolytes have been studied extensively.

The current cross-sectional study was performed to assess serum magnesium levels in cases with CKD and to detect the correlation of serum magnesium with clinical features and severity of renal impairment.

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 on serum magnesium levels in CRF patients observed 10 patients (8.7%) had Mg levels of <0.7 mmol/L, 13(11.3%) had between 0.7 to 1.1 mmol/L while 26 (23.9%) showed levels of

>1.1 mmol/L.113.

The mean serum magnesium value was high [5.28 (±0.44)] in patients with encephalopathy than patients without encephalopathy [3.93 (±1.45)] which is similar to study done by Sharma SK et al where higher serum magnesium levels were observed in patients of chronic renal failure with encephalopathy than in those without.114 In present study the mean serum magnesium value was high in patients with vomiting and nausea which was 4.96 (±0.95) and

4.71 (±1.16) while mean serum magnesium value was in patients without oliguria and oedema which was 4.82 (±0.98) and 4.71 (±1.04). In present study it was observed, there was bradycardia in a patients with high serum magnesium levels with statistically significant correlation (p=0.0120) which is similar in study done by Sharma SK et al.[41]

The mean serum magnesium was 4.89 (±1.05), 3.84 (±1.47) and 3.24 (±1.45) in patients with heart rate <60, 60-100 and >100 respectively. The correlation of serum magnesium and dialysis among patients showed that serum magnesium before dialysis was more (4.66 ±1.61) compared to after dialysis (2.84 ±0.92) with statistically significant value (p < 0.001).

CONCLUSION

The serum magnesium among patients with CKD had hyper magnesium. The serum magnesium level rises as kidney function deteriorates. There is significant fall in serum magnesium level after dialysis. There is significant high level of serum magnesium in patients with encephalopathy and patients with bradycardia. All patients suffering from CKD should be advised low magnesium in diet similar restriction to potassium to prevent CNS depression & cardiac arrhythmia. Serum magnesium should be measured regularly in patients with CKD and adjust dialysate

magnesium accordingly to maintain plasma magnesium within normal range. Serum magnesium is a worthwhile tool for assessing duration of disease and morbidity in patients with CKD. Its estimation helps in evaluating conservative treatment and dialysis in CKD. Hence early evaluation and treatment of underlying cause for CKD is necessary to prevent further complication and kidney damage.

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