Hypomagnesemia in Pre-Renal Acute Kidney Injury Patients with Non-Recovery of the Renal Functions

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ABSTRACT

Objective: To determine the hypomagnesaemia frequency in pre-renal acute kidney injury (AKI) patients with non-recovery of renal functions.

Study Design: Cross-sectional study.

Place and Duration of Study: Al-Noor Specialist Hospital Holy Makah, Saudi Arabia, from Jul 2014 to Jan 2015.

Methodology: A total of 150 acute kidney injury patients qualifying the inclusion/exclusion criteria were enrolled in this study. Serum magnesium (Mg) levels were measured for all the patients. Serum magnesium level <0.70 mmol/L (<1.7 mg/dL) was labeled as hypomagnesaemia.

Results: The mean age of the patients was 51.64 ± 13.61 years, with 31% males and 69% females. Hypertension was present in 58 (38.7%) patients, 38 (25.3%) patients were obese, and hypomagnesaemia was present in 25% patients. A statistically insignificant difference was found between age of patients (p=0.086) and gender (p=0.970).

Conclusion: Our study showed that in patients with acute kidney injury with non-recovery of renal functions, the rate of hypomagnesaemia is quite high. Therefore patients with non-recovery should be screened for magnesium levels in future acute kidney injury.

Keywords: Hypomagnesaemia, Magnesium Level, Non-Recovery of Renal Functions, Pre-Renal Acute Kidney Injury, Renal Functions.

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INTRODUCTION

Approximately 5.7% of hospitalized patients suffer from acute kidney injury (AKI).[1] Mortality rates among patients with AKI remain unacceptably high. Inadequate renal perfusion is the cause of pre-renal a zotemia. Extracellular fluid (ECF) volume depletion and cardiovascular disease are the leading causes of pre-renal azotemia accounting for 50 to 80% cases of potentially reversible AKI.[2] During the recovery phase of AKI, hypokalemia, hypocalcaemia, hypomagnesemia, and hypophosphatemia are common electrolyte disturbances. [3,4]

In recovering AKI cases, magnesium deficiency is a relatively common clinical problem that induces endothelial dysfunction and a pro-inflammatory state.[5] Clinical presentation of hypomagnesemia usually resembles and coexists with hypokalemia and hypocalcaemia.[6] The prevalence rates among indoor patients vary from 4.6–47%. This wide range signifies the diverse variety of the patients studied and different cut-off values adopted for defining hypomagnesemia.[7,8]

A study by Santos *et al*, showed that in patients with non-recovery of renal function hypomagnesemia, an independent risk factor (p=0.03).[7] These findings were in accordance with another study by Alves *et al*.[9] They showed that as compared with patients who recovered renal function, the prevalence of hypomagnesemia was higher in patients who did not recover renal function (70% versus 31%, p=0.003); and in patients with AKI it was 47%.

We planned the study to determine the frequency of hypomagnesemia in AKI patients and the frequency of non-recovery of renal function in AKI patients with hypomagnesemia.

METHODOLOGY

The cross-sectional study was conducted from July 2014 to Jan 2015 at Al-Noor Specialist Hospital, Holy Makkah, Saudi Arabia. Hospital Ethical Review Committee permission was sought (ERC number: 62947) before the data collection. WHO sample size calculator was use for sample size calculation by keeping the percentage of hypomagnesemia in AKI

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patients at 70%,[10] the margin of error at 8%, and confidence level at 95%. After informed written consent, one hundred and fifty patients were enrolled in the study by non-probability consecutive sampling.

Inclusion Criteria: All the patients of age 18-65 years in pre-renal AKI, with non-recovery of renal functions at 72 hours despite treatment were included in the study.

Exclusion Criteria: Patients with renal or post-renal azotemia based on laboratory investigations (BUN/ creatinine ratio <20), diabetes (based on the history of insulin or oral hypoglycemic use or BSR >200 mg/dl) were excluded from the study.

After taking relevant history, the clinical examination was carried out. Serum magnesium levels were taken for all the AKI patients at the time of recruitment. Presence of serum magnesium level <0.70 mmol /L (<1.7 mg/dL) was labeled as hypomagne-semia.[11]

Statistical Package for Social Sciences (SPSS) version 23.0 was used for the data analysis. Quanti-tative variables were summarized as mean ± SD. Frequencies and percentages were calculated for categorical variables, e.g. gender, hypertension, obesity (BMI >30 kg/m2), hypomagnesemia, and non-recovery of renal function. Chi-square test was applied to find out the association. The *p*-value of <0.05 was conside-red statistically significant.

RESULTS

A total of 150 cases were included in this study. The mean age of the study population was 51.46 ± 13.61 years. In this study, 47 (31 %) patients were males and 103 (69 %) patients were females. Hypertension was present in 58 (38.7 %) patients, whereas obesity was seen in 38 (25.3 %) patients (Table-I). Hypomagnesemia was present in 38 (25.3 %) patients (Figure).

We categorized the data in different age groups and found that in patients with age <40, hypomagnesemia was present in 5 (14.3%) cases. Similarly, in patients with age ≥40, hypomagnesemia was present in 33 (28.7%) cases. A statistically insignificant difference was found between hypoma-gnesemia and age (*p*-value=0.086). Hypomagnesemia among males was present in 26 (25.2%) cases. Similarly, hypomagnesemia was present in 12 (25.5 %) cases in female patients.

Table-I: Distribution of hypertension and obesity.

		Hypertension		Obesity	
		Frequency	Percent	Frequency	Percent
Hypomagne-semia	Present	58	38.7%	38	25.3%
	Absent	92	61.3%	112	74.7%

A statistically insignificant difference was found between hypomagnesemia and gender (*p*-value=0.970). Hypomagnesemia was present in 14 (24.1 %) cases of hypertension. Similarly, in non-hypertensive patients, hypomagnesemia was present in 24 (26.1 %) cases.

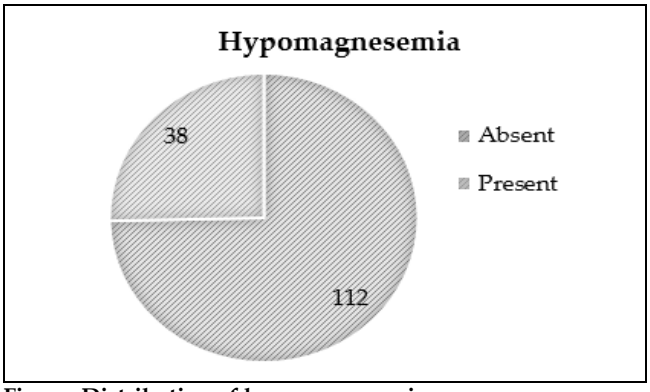

Figure: Distribution of hypomagnesemia.

A statistically insignificant difference was found between hypertension and hypomagnesemia (*p*-value= 0.789). We found that in obese patients, hypomagnesemia was present in 14 (36.8 %) cases. Similarly, in non-obese patients, hypomagnesemia was present in 24 (21.4 %) cases. A statistically insignificant difference was found between obesity and hypomagnesemia (*p*-value=0.059), as shown in the Table-II.

Table-II: Distribution of hypomagnesemia in accordance with Age, gender, hypertension and obesity.

Hypomag-nesemia	Age		Gender		Hypertension		Obesity*	
	< 40 years	≥ 40 years	Female	Male	Female	Male	Female	Male
Present	5 (14.3%)	33 (28.7%)	26 (25.2%)	12 (25.5%)	14 (24.1%)	24 (26.1%)	14 (36.8%)	24 (21.4%)
Absent	30 (85.7%)	82 (71.3%)	77 (74.8%)	35 (74.5%)	44 (75.9%)	68 (73.9%)	24 (63.2%)	88 (78.6%)
p-value	0.086		0.970		0.789		0.059	

In our critically ill AKI patients, hypomagnesemia was found an independent risk factor for non-recovery of renal function.

DISCUSSION

This present study was carried out at the Al-Noor Specialist Hospital, Holy Makkah, Saudi Arabia, to determine the frequency of hypomagnesemia in pre-renal AKI patients with non-recovery of renal function.

Hypomagnesemia is a relatively common clinical problem, seen in almost 12% of indoor patients.[9] The incidence in critical care patients is high, up to 65%. Various factors, including nutrition, hypoalbumi-nemia, and drugs can contribute.[10,11]

AKI is common in HIV patients and associated with pre-existing renal derangements. Overall, magnesium is the fourth most common and second most common intracellular cation in humans. A study by Barbosa *et al*, showed that magnesium supple-mentation to correct asymptomatic hypomagnesemia in critically ill patients is associated with a lower incidence of AKI.[12]

In Turkish renal transplant recipient patients who have been treated with tacrolimus, the frequency of hypomagnesemia was high. Risk factors identified for post-transplant hypomagnesemia were increased serum calcium and glucose levels and short post-transplant duration.[13]

Hypomagnesemia is a risk factor for AKI. Chen *et al*, showed that serum magnesium levels are closely related to the mortality rate in patients in ICU, so more attention should be paid to the occurrence of hypomagnesemia in critically ill patients.[14]

Significant magnesium depletion has also been seen in patients with chronic ischemic heart disease, hypertension and stroke.[15] Recent in vitro studies on humans, rats and dogs' aortic and cerebrovascular smooth muscle cells have shown that hypomagnesemia was associated with the expression of proto-oncogenes (c-fos and c-jun), as well as of the nuclear factor-kappa B (NF-κB) transcription factor.[15,16]

Wyatt *et al*, analyzed various risk factors for AKI in HIV-infected patients, including low serum albumin (<3.7 mg/dl), low body mass index (<18.5 kg/m^2), HCV co-infection, black race, male gender, older age, diabetes mellitus, hypertension, cardiovascular disease and hypomagnesemia. These are clinical predictors for AKI and its outcomes.[17] The frequency of hypomagnesemia in our study was 25.3%. A statistically insignificant difference was found in hypomagnesemia in accordance with age, gender, hypertension and obesity of the patients.

A previous study concluded that for non-recovery of renal function in a cohort of critically ill AKI patients, hypomagnesemia was an independent risk factor. The prevalence of hypomagnesemia in their study was 63%.[8]

The prevalence of hypomagnesemia (total serum magnesium concentrations) widely varies in different studies, with a range of 11-65%. The effects on morbidity and mortality also remain controversial.[17,18] In critically ill patients, hypomagnesemia is one of the most common electrolyte abnormalities.

Whang *et al*, found the prevalence of hypomagnesemia with different electrolytes defi-ciency, highest with hypokalemia (42%) and lowest with hypocalcaemia (22%).[19]

In a study by Rubeiz *et al*,[20] hypermagnesemia was associated with a lower risk of neurological deficit/death; there was a dose-response relationship between serum magnesium concentration and risk of neurological deficit/death.

According to our study, the frequency of hypomagnesemia in pre-renal AKI patients with non-recovery of renal functions was 25.3%. There is no statistically significant relationship between the presence and absence of hypomagnesaemia regarding age, gender, hypertension or obesity. Further studies need to be done to see whether there is a relationship between the recovery of renal functions and serum magnesium level. However, we suggest screening the AKI patients for hypomagnesemia.

CONCLUSION

Our study showed that in patients with acute kidney injury with non-recovery of renal functions, the rate of hypomagnesemia is quite high. Therefore patients with non-recovery should be screened for magnesium levels in future acute kidney injury.

Conflict of Interest: None.

Authors' Contribution

ZH: Conception, data collection & Interpretation, RSH: Conception, design & interpretation, FA: Data analysis & interpretation, WA: Conception, design & interpretation, SM: Conception, design & interpretation.

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