Original Article

Magnesium Deficiency in Hospitalized Patients with Hypokalemia

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Abstract

Background: When magnesium deficiency coexists with hypokalemia, it aggravates the hypokalemia, potentiates its adverse effects, and also renders it refractory to treatment. Despite the impact of magnesium deficiency on the clinical effects of hypokalemia, plasma magnesium is not routinely measured in patients with hypokalemia in our setting. **Objectives:** The objective of this study was to examine the frequency of hypomagnesemia among hospitalized patients with hypokalemia at a tertiary hospital in Northeastern Nigeria. **Subjects and Methods:** A cross-sectional analytical study carried out among 80 hospitalized patients (40 with hypokalemia and 40 with normal plasma potassium). Clinical details of the study individuals were obtained from hospital case notes. Plasma magnesium was measured, and the frequency of hypomagnesemia was compared between the two study groups. **Results:** The mean plasma magnesium was significantly lower in the hypokalemic group than in the normokalemic group (0.67 ± 0.05 vs. 0.81 ± 0.04 mmol/L, $P < 0.05$). The frequency of hypomagnesemia in the hypokalemic participants was higher than in normokalemic participants (52.5% vs. 22.5%). Hypomagnesemia was twice as likely to be found in the hypokalemic participants as in the normokalemic participants. **Conclusions:** Hypomagnesemia is common among hospitalized patients with hypokalemia in our setting. We recommend further studies, using larger sample size, which will identify clinical conditions that are frequently associated with the simultaneous occurrence of these two disturbances and determine the clinical value of routine measurement of magnesium in patients with hypokalemia in our setting.

Keywords: Hospitalization, hypokalemia, magnesium

Introduction

Hypokalemia is a common electrolyte abnormality encountered in clinical practice. It has been found in up to 21% of hospitalized patients according to reports from studies done mainly among Caucasians.[1,2] Hypokalemia is associated with alterations in the function of several organs systems, especially neuromuscular and cardiovascular systems, with resultant increase in morbidity and mortality in affected patients.[3] The effective treatment of hypokalemia requires the identification of its cause.[4]

Hypokalemia has been found to be frequently associated with hypomagnesemia in hospitalized patients according to previous reports mainly from studies done among Caucasians.[5-9] Magnesium deficiency, when present, worsens hypokalemia by aggravating renal wasting of potassium and enhances the adverse effects of hypokalemia. Hypomagnesemia also renders hypokalemia refractory to potassium replacement therapy; coadministration of magnesium is required for the correction of hypokalemia associated with hypomagnesemia.[10]

Detection of coexisting hypomagnesemia and early intervention is crucial for effective treatment and prevention of complications hypokalemia on target tissues.[11]

Data on the frequency of hypomagnesemia among hospitalized patients with hypokalemia in Nigeria are limited, as most hospitals do not routinely measure plasma magnesium.

The aim of this study was to determine the prevalence of hypomagnesemia in hospitalized patients with hypokalemia and to suggest or otherwise, the routine measurement of plasma magnesium in patients with hypokalemia in our setting.

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Subjects and Methods

The study was carried out at the medical and surgical wards of the Federal Teaching Hospital, Gombe, Northeastern Nigeria, to determine the frequency of hypomagnesemia in nonselected, consecutive male and female adult patients aged 18 years and above whom, either on admission to the hospital or during hospitalization were found to have hypokalemia.

Forty patients who were hospitalized between November 2017 and June 2018 and had hypokalemia at two sequential measurements were included the study. Forty hospitalized patients with normal levels of plasma potassium were included as controls. We excluded patients who were receiving magnesium-containing antacids and/or any form of magnesium supplements. Cigarette smoking and history of alcohol abuse were also part of the exclusion criteria. All the study participants are Nigerians of African descent and living in Gombe State. The study protocol was approved by the Health Research Ethics Committee of Federal Teaching Hospital, Gombe. Informed consent for participation in the study was obtained from each of the study participants. The study did not interfere with the management of the study participants throughout their hospital stay in any way.

Data collection

Demographic and clinical data of all the study participants were obtained from patients folders. Information, including age, sex, body height and weight, blood pressure, smoking status, alcohol ingestion, diagnosis, and treatment, was recorded. The body mass index was calculated as weight in kilogram divided by the square of height in meters and expressed as kg/m^2.

Sample collection and processing

A tourniquet was applied to the upper arm 2 cm above the antecubital fossa to visualize the veins. The antecubital fossa was cleaned with a methylated spirit-soaked swab and allowed to dry. The most prominent vein was then identified and punctured with a sterilized 5-ml syringe and 21-G needle. Blood sample (5 ml) was collected and the needle gently withdrawn and hemostasis secured by applying pressure with a dry cotton wool. The blood collected was transferred to a heparinized bottle and transported immediately to the laboratory at room temperature, where it was centrifuged at 4000 rpm for 10 min. The supernatant plasma was pipette into another plain bottle. Aliquots of the plasma samples were taken and analyzed for magnesium. Plasma magnesium level was measured by colorimetric assay kit (Agappe Diagnostics Limited, Kerala, India). Potassium and other electrolytes were measured by ion-selective electrodes. Plasma magnesium levels <0.75 mmol/L were considered as hypomagnesemia,[12] and plasma potassium levels <3.5 mmol/L were considered as hypokalemia. Hemolyzed samples were excluded from the analysis, and delayed separation of plasma from cells was avoided. All blood samples were treated the same throughout the process of blood collection, transport, and analysis. All laboratory analyses were conducted at the Chemical Pathology Laboratory of Gombe State University/Federal Teaching Hospital, Gombe.

Statistical analysis

Data were summarized as mean ± standard deviation, frequencies, and proportions and presented using tables. We compare the differences of means between groups using *t*-test. All *P* values were two-sided and were considered statistically significant if <0.05. All statistical analyses were done using the SPSS Statistics for Windows, Version 20.0 (Armonk, NY: IBM Corp. 2011).

Results

A total of 80 participants included in the study were categorized into two groups comprising forty hypokalemic and forty normokalemic patients. Demographic and biochemical parameters of the two groups are presented in Tables 1 and 2.

Hypokalemic group

The mean age was 54 years and was predominantly females (57.5%). The mean plasma potassium level was 2.6 mmol/L ± 0.03 (minimum 1.6 and maximum 2.80 mmol/L), and the mean plasma magnesium level was 0.67 mmol/L ± 0.05 (minimum 0.50 and maximum 0.83 mmol/L). Hypomagnesemia was present in 52.5% (21 out of 40).

Normokalemic controls

The mean age was 49 years. Eight (20%) were female, and 32 (80%) were male. Mean plasma potassium was 4.3 ± 0.2 mmol/L (minimum 3.6 and maximum 5.1 mmol/L), and the mean plasma magnesium level was 0.81 ± 0.04 mmol/L (minimum 0.65 and maximum 0.94 mmol/L). Hypomagnesemia was present in 22.5% (9 out of 40) of the participants in the controls.

Hypomagnesemia was twice as likely to be found in the hypokalemic participants (52.5%) than in the normokalemic

Table 1: Clinical and biochemical characteristics of the study participants

Variables	Hypokalemic group (*n*=40)			Normokalemic group (*n*=40)			*P*
	Mean±SD	Minimum	Maximum	Mean±SD	Minimum	Maximum	
Age (years)	54±5.30	29	74	49.3±4.1	31	68	0.000
Sex (male/female)	17/23	-	-	32/8	-	-	-
BMI (kg/m^2)	27.3±1.7	21.1	34.4	25.8±1.9	18.2	32.4	0.000
Plasma potassium (mmol/L)	2.6±0.03	1.6	2.8	4.3±0.02	3.6	5.1	0.000
Plasma magnesium (mmol/L)	0.67±0.05	0.50	0.83	0.81±0.04	0.65	0.94	0.000

SD: Standard deviation, BMI: Body mass index

Table 2: Frequency of hypomagnesemia among the study participants

Plasma magnesium (mmol/L)	Frequency (%)	
	Hypokalemic group ($n=40$)	Normokalemic group ($n=40$)
Hypomagnesemia (<0.75)[12]	21 (52.5)	9 (22.5)
Normomagnesemia (0.75-0.95)[12]	19 (47.5)	31 (77.5)
Hypermagnesemia (>0.95)[12]	-	-

participants (22.5%). The mean plasma magnesium was significantly lower in the hypokalemic participants than in the normokalemic participants (0.67 ± 0.05 vs. 0.81 ± 0.04 mmol/L, $P < 0.05$).

Discussion

We examine the frequency of hypomagnesemia in a group of hospitalized patients with hypokalemia at a tertiary hospital in Northeastern Nigeria. In the present study, the mean plasma magnesium level in patients with hypokalemia was significantly lower than in patients with normokalemia. It was also observed that the frequency of hypomagnesemia was higher among patients with hypokalemia, occurring in 1 in 2 participants (52.5%) when compared with the normokalemic patients (22.5%). Similar findings of frequent association between hypokalemia and hypomagnesemia were reported in previous studies.[5,6] Furthermore, in support of the results of this study, Whang *et al*.[7] reported that 42% of patients on admission with hypokalemia also have concomitant hypomagnesemia. However, the findings of Deheinzelin *et al*.[9] and Watson and O'Kell.[13] did not show a significant association between serum magnesium and potassium.

The differences in the reported findings between different studies might be explained by the heterogeneity of the study population. Patients with conditions that are associated with increase in renal distal sodium delivery and/or hyperaldosteronism (e.g., diuretics therapy, diarrhea, and congestive cardiac failure), which are required for the enhanced renal wasting of potassium, in magnesium deficiency state, are more likely to develop hypokalemia than patients with isolated magnesium deficiency.

Magnesium plays a critical role in potassium metabolism. Na^+/K^+ ATPase pump which facilitates the cellular uptake of potassium requires magnesium for its activation. Hypomagnesemia is, therefore, associated with impairment or decreased activity of the pump with the resultant leakage of potassium into the extracellular fluid and its subsequent excretion through the kidneys and gut.[14] Magnesium deficiency also enhances renal potassium wasting by increasing renal distal tubular potassium secretion because low intracellular magnesium releases the magnesium-mediated inhibition of the renal outer medullary potassium channel in the renal distal tubules, thereby increasing potassium secretion.[15] Magnesium deficiency may, therefore, have contributed to the occurrence of hypokalemia in hospitalized patients in our setting. Clinical signs and symptoms of magnesium deficiency are nondistinctive,[16] and may clinically present similar to other electrolyte imbalances, including hypokalemia, which often occurs concurrently.[8] Magnesium deficiency should, therefore, be suspected and treated in patients with hypokalemia, as failure to recognize and treat coexistent hypomagnesemia may lead to refractory hypokalemia.[11]

Limitation

While facilities for the measurement of free-ionized magnesium (active component) were not readily available in our setting, total plasma magnesium was rather measured in our study. These could have effect on the results of this study, as changes in plasma levels of proteins and other anions that chelate magnesium may affect the total plasma magnesium level without necessarily affecting the plasma-ionized magnesium or total body magnesium.[17] The relatively small sample size could also be a limitation for the analysis of data.

Conclusions

Hypomagnesemia is common among hospitalized patients with hypokalemia in our setting. We recommend further studies, using larger sample size, which will identify clinical conditions that are frequently associated with the simultaneous occurrence of these two disturbances and determine the clinical value of routine measurement of magnesium in patients with hypokalemia in our setting.

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Conflicts of interest

There are no conflicts of interest.

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