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Research Article

Examining the Frequency of Hypomagnesemia in Multiple Trauma Patients Hospitalized in the Intensive Care Unit

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ABSTRACT

Background: Electrolyte imbalance is one of the influential causes in determining the outcome of traumatic patients. One of the electrolytes that get less attention from healthcare providers is magnesium. Therefore, this study investigated the frequency of hypomagnesemia in trauma patients hospitalized in the intensive care unit.
Methods: The descriptive-cross-sectional study was conducted after approval at Zahedan University of Medical Sciences on 118 patients with multiple traumas from 2021 to 2022. Patients were selected by convenience sampling method according to the inclusion criteria. Age, sex, weight, body mass index, level of consciousness, and level of blood serum electrolytes were measured and recorded on the first and fifth days after hospitalization. The data were analyzed and compared using descriptive statistics, chi-square, and independent t-test.
Results: Of 118 patients studied, 81 (68.6%) were male, and 38 (31.4%) were female. On the fifth day after hospitalization, the mean serum magnesium level of the patients was 1.4 ± 0.81 mg/dL. 87 patients (73.7%) had normal magnesium serum levels, 27 patients (29.9%) had hypomagnesemia, and 4 patients (3.4%) had severe hypomagnesemia. No statistically significant relationship existed between hypomagnesemia and gender, age group, and comorbidity diseases. The level of other blood serum electrolytes on the fifth day after hospitalization, age, weight, body mass index, and status of consciousness was not statistically significant between the two groups of patients with hypomagnesemia and without hypomagnesemia.
Conclusion: Trauma and the subsequent treatment measures lead to decreased magnesium serum levels in intensive care patients. Therefore, the normal serum level of other electrolytes should not be considered a diagnostic indicator for the normality of magnesium serum level. Magnesium should be measured along with other electrolytes to make a timely decision to replace magnesium supplements in a patient with hypomagnesemia.

Introduction

Magnesium is an important mineral intracellular element. Magnesium acts as a vital factor in any reaction that requires ATP. Therefore, the deficiency of this ion can significantly affect cellular metabolism. Magnesium also acts as a calcium channel antagonist and plays a vital role in modulating processes related to intracellular calcium concentration, such as muscle contraction and insulin release [1-2]. Despite the important function of this inorganic ion, its serum level is not regulated and protected by a specific hormone. Most of the body's magnesium reserves are intracellular and are

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mainly located inside the bones. But they are not easily accessible to the extracellular fluid. Regulation of magnesium levels is done by digestive absorption and renal excretion-reabsorption [3]. Hypomagnesemia refers to a decrease in serum magnesium level below 0.66 mmol/L (1.6 mg/dL), with or without depletion of whole-body magnesium stores. As long as the serum level is reduced to less than 0.5 mmol/L (1.2 mg/dL), significant clinical signs and symptoms do not occur [4]. ICU patients have many risk factors that lead to disturbances in magnesium levels [5]. Loss of magnesium from the digestive system, excretion of magnesium from the kidneys due to the administration of diuretics or dysfunction of the renal tubules [6], and tissue sequestration due to surgery or trauma are the most important factors leading to hypomagnesemia [7]. Hypomagnesemia has been reported in 12% of hospitalized patients and 60-65% of intensive care unit patients [8]. Clinical manifestations of hypomagnesemia include neuromuscular excitability, ranging from tremors, fasciculation, and tetany to seizures and neuropsychiatric disorders such as apathy, delirium, and even loss of consciousness. Other life-threatening complications are not related to hypomagnesemia, rather, it is caused by disturbances in the serum level of other electrolytes such as potassium and calcium. A simultaneous change in the level of the electrolyte creates atrial and ventricular dysrhythmias, sensitivity to digoxin intoxication, and sudden death [4, 9-10]. Physicians notice hypomagnesemia less than other electrolyte deficiencies, and its serum level is not routinely measured [9]. The association between hypomagnesemia and hypermagnesemia with increased mortality has been reported in several studies in patients with renal failure [11-13]. But some studies mentioned that hypomagnesemia is more related to increased mortality of patients than hypermagnesemia [13-14]. Therefore, this study was conducted to investigate the frequency of hypomagnesemia in trauma patients hospitalized in the intensive care unit.

Methods

The present descriptive-cross-sectional study was conducted after obtaining the necessary permits from Zahedan University of Medical Sciences and presenting them to Khatam Al-Anbia Hospital from 2021 to 2022. The sample size, according to the previous study, which reported the prevalence of hypomagnesemia was 46.7% [15], and the sample size calculating formula was estimated to be 118 people by considering the type 1 error at 0.05 and a power of 80%. Therefore, 118 patients with multiple traumas at the beginning of hospitalization in the intensive care unit were included in the study using a convenience sampling method based on the inclusion criteria.

Inclusion criteria include: age between 18 and 65 years, not taking drugs that affect the level of serum electrolytes in the last two weeks (diuretics, steroids, compounds containing magnesium), not suffering from kidney and liver failure, not having diarrhea, malnutrition, and significant weight loss, during the last month and not consuming alcoholic beverages. Patients who died before the second measurement of magnesium serum level (5 days) were excluded from the study.

After the patients were included in the study, the demographic characteristics of the patients, level of consciousness, and comorbidity diseases were recorded in a form designed to collect data. According to the routine of the hospital, blood samples were sent to the laboratory for counting blood cells, checking kidney and liver function, and measuring serum electrolytes, including calcium, sodium, and potassium, from all patients admitted to the intensive care unit. Therefore, magnesium and phosphorus were added to the department's routine test request. The patient's test results were followed up and recorded in the data collection form. Patients were treated according to the standard hospital protocol and received no oral or intravenous magnesium supplements until the fifth day of hospitalization. Then, on the fifth day of hospitalization, 5 cc of blood was collected from the antecubital vein under sterile conditions and sent to the laboratory to measure serum electrolytes and albumin levels. The patient's test results were followed up and recorded in the data collection form. Magnesium less than 1.7 and more than 2.6 mg/dL was considered hypomagnesemia and hypermagnesemia, respectively, and less than 1 mg/dL was regarded as severe hypomagnesemia. After completing the sampling process, the collected data was analyzed with spss software.

Statistical Analysis

Descriptive statistics (prevalence, mean and standard deviation) were used to examine the patients' demographic variables and serum electrolyte levels. The chi-square test was used to investigate the relationship between age group, gender, and comorbidity disease of patients with hypomagnesemia. Independent t-test was also used to compare age, weight, level of consciousness, body mass index, serum levels of calcium, phosphorus, potassium, sodium, and albumin between two groups with hypomagnesemia and without hypomagnesemia on the fifth day of hospitalization.

Ethical considerations

Informed consent was obtained from first-degree family members to participate patients in the study. The study with code IR.ZAUMS.REC.1400.111 was approved by the ethics committee of Zahedan University of Medical Sciences. All research permits were shared with hospital managers and patients' family members to make sure that the study was legal.

Results

Out of 118 patients studied, 81 (68.6%) were male, and 38 (31.4%) were female. 81 (68.6%) patients had no comorbidity disease, 16 (13.6%) had diabetes, 11 (9.3%) had hypertension, 6 (5.1%) had ischemic heart disease, and 4 patients (3.4%) were suffering from central nervous system (CNS) disease. The mean level of consciousness of the patients based on the Glasgow coma scale on admission was 9.04 ± 3.08. The mean age of the patients was 38.3±12.49 years. The mean weight of the patients was 68.6±16.2 kg. The mean BMI of the patients was 22.8 ± 3.1 kg/m2. The mean level of electrolytes in the patient's serum at the time of admission was as follows: sodium 141.8±2.05 mg/dl, potassium 4.06±0.68 mg/dl, calcium 8.87±1.13 mg/dl, phosphorus 4.83±0.89 mg/dl, and magnesium 2.02±0.47 mg/dl. Examination of the serum magnesium level on the fifth day after hospitalization showed that the mean serum magnesium level of the patients was 1.4±0.81 mg/dL. 87 patients (73.7%) had normal magnesium serum levels, 27 patients (29.9%) had hypomagnesemia, and 4 patients (3.4%) had severe hypomagnesemia. In investigating the relationship between hypomagnesemia with gender, age group, and comorbidity disease with the chi-square test, the results showed no statistically significant connection between hypomagnesemia with any of the variables (Table 1).

Comparing the level of other blood serum electrolytes on the fifth day after hospitalization, age, weight, body mass index, and status of consciousness between the two groups of patients with hypomagnesemia and without hypomagnesemia also did not show a statistically significant difference with the independent t-test (Table 2).

Table 1- Comparison of the frequency distribution of hypomagnesemia according to gender, age group, and comorbidity disease

Variable		Serum magnesium level			P value
		Normal	**hypomagnesemia**	**Severe hypomagnesemia**	
Age	Less than 20 years	5 (74.1%)	1 (14.3%)	1 (14.3%)	
	20 to 25 years	8 (66.7%)	1 (33.3%)	-	
	26 to 30 years	11 (57.9%)	7 (36.8%)	1 (5.3%)	
	31 to 35 years	13 (65%)	6 (30%)	1 (5%)	
	36 to 40 years	10 (100%)	-	-	0/28
	41 to 45 years	9 (81.8%)	2 (18.2%)	-	
	46 to 50 years	10 (66.7%)	5 (33.3%)	-	
	51 to 55 years	10 (90.9%)	1 (9.1%)	-	
	56 to 60 years	7 (87.5%)	1 (12.5%)	-	
	61 to 65 years	4 (80%)	-	1 (20%)	
Gender	Male	59 (72.8%)	19 (23.4%)	3 (3.7%)	0/8
	Female	28 (75.7%)	8 (21.6%)	1 (2.7%)	
Comorbidity disease	Without comorbidity disease	60 (74%)	20 (24.7%)	1 (1.3%)	
	Diabetes	11 (68.8%)	4 (25%)	1 (6.3%)	
	Hypertension	9 (81.8%)	2 (18.2%)	-	0/89
	Ischemic heart disease	5 (83.3%)	1 (16.7%)	-	
	Central nervous system disease	2 (50 %)	-	2 (50 %)	

Table 2- Examining the relationship between the levels of other serum electrolytes and quantitative variables between two groups with hypomagnesemia and without hypomagnesemia

Variable	Serum magnesium level		P value
	Normal	**hypomagnesemia**	
Age	31.12 ± 8.26	44.96 ± 10.81	0.762
Weight (Kg)	69.8 ± 11.2	57.6 ± 12.06	0.212
Body mass index	23.14 ± 2.09	21.11 ± 3.12	0.303
level of consciousness (GCS)	9.8 ± 2.2	8.9 ± 2.04	0.98
Sodium (mg/dL)	144.1 ± 3.8	141.09 ± 1.9	0.07
Potassium (mg/dL)	4.5 ± 0.23	4.9 ± 0.98	0.10
Calcium (mg/dL)	8.18 ± 1.08	8.68 ± 0.98	0.09
Phosphorus (mg/dL)	4.04 ± 0.66	3.97 ± 0.89	0.218
Albumin (g/dL)	3.79 ± 1.06	3.25 ± 0.96	0.89

Discussion

The results of the present study showed that the serum level of magnesium of patients with multiple traumas decreases after 5 days of hospitalization in the ICU without changing the serum level of other electrolytes. Also, the decrease in magnesium serum level is not related to the age, weight, and gender of the patients. Frankel et al.'s study, showed that trauma patients suffer from hypomagnesemia more than other hospitalized patients [16]. The survey by Polderman et al. also stated that patients with traumatic head injuries are subjected to treatments such as induced hypothermia or barbiturate coma. These treatment methods disrupt the amount of urine output and the ability to self-regulate the body's electrolyte levels. Therefore, patients experience a decrease in magnesium serum levels. Therefore, preventive electrolyte replacement should be considered for these patients [17]. However, none of the patients in the present study underwent induced hypothermia. But, according to the standard treatment protocol, all patients received a continuous infusion of fentanyl and midazolam for pain control and ventilator tolerance. They were also given phenytoin or phenobarbital every eight hours to prevent seizures, both of which, along with head injury, lead to a reduced level of consciousness and reduced ability of the body to self-regulation [18-20].

On the other hand, head trauma patients receive drugs such as mannitol or hypertonic sodium and diuretics such as Lasix or acetazolamide to control intracerebral pressure. These drugs lead to renal dysfunction, increased urinary output, and electrolyte imbalance [21-24]. Therefore, healthcare providers must consider the preventive administration of electrolytes in these patients [24]. On the other hand, hypermagnesemia can also lead to severe muscle weakness, respiratory depression, hypotension, cardiac arrhythmia, and ultimately cardiac arrest [25]. Therefore, magnesium replacement supplements should not be used as a routine treatment in the intensive care unit.

Consequently, it is necessary to measure this ion frequently in patients admitted to the intensive care unit and replace it based on the patient's needs [26]. The study of Sadeghi Bojd et al., conducted in the pediatric intensive care unit, also reported that 47.7% of patients had hypomagnesemia. Patients with hypomagnesemia had lower weight and higher calcium levels, potassium, and calcium. Still, there was no statistically significant difference in terms of weight and levels of serum electrolytes between the two groups with hypomagnesemia and normal serum magnesium. In the present study, patients with hypomagnesemia had a lower mean weight. The mean values of other serum electrolytes were similar; in the case of potassium, they were higher than patients with normal magnesium levels. However, there was no statistically significant difference between the two groups in any of the cases [27]. The study by Peivandi Yazdi et al. also showed that patients admitted to the intensive care unit after extensive abdominal surgeries have hypomagnesemia from the first 24 hours, while the serum levels of other electrolytes are normal. Although the results of this study showed that hypomagnesemia is a common electrolyte disorder in the ICU, however, it is different from the results of the present study because the patients examined in the study by Peivandi Yazdi et al. had long-term diseases and intra-abdominal problems. Therefore, this issue can lead to insufficient intake or excess excretion of electrolytes and a drop in serum levels even before hospitalization. While the patients examined in the present study did not have an acute illness before the accident.

For this reason, measuring the serum level of electrolytes on the first day showed no disturbance. However, on the fifth day, serum magnesium decreased, which indicates the effect of severe trauma and hospitalization in the ICU ward in decreasing the serum magnesium of patients [15]. The intentional causes of electrolyte changes in trauma patients are changes in cellular metabolism, increased intracellular pH, and accumulation of magnesium inside cells. These changes can lead to an increase in cerebral ischemia, a decrease in consciousness, and an increase in patient mortality [28]. In confirmation of the results of the above studies, Up1ala et al.'s systematic review also reported that patients admitted to the intensive care unit have hypomagnesemia, and hypomagnesemia leads to an increase in the time of mechanical ventilation, an increase in the length of stay in the ICU, and an increase in the mortality rate of these patients [8].

Conclusion

Trauma and hospitalization in the intensive care unit lead to hypomagnesemia. Therefore, the serum magnesium level of trauma patients, along with other electrolytes, should be monitored from the beginning of the admission of patients in the intensive care unit so that in case of a drop, the replacement of magnesium supplements can be decided on time.

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