Evaluation of Serum Magnesium Level Among Patients with Essential Hypertension in Erbil-Iraq

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Abstract

Background: Hypertension is a well-established risk factor for cardiovascular diseases with an ongoing global increase in incidence. Low Magnesium may play a critical role in cardiovascular physiology. Although many reports have mentioned the correlation between low serum magnesium levels and hypertension, the results were conflicting.

Objective: To measure the levels of serum magnesium in hypertensive patients, and to evaluate the prevalence of hypomagnesemia among them.

Patients and Methods: A case-control study from June 2019 to December 2019 was carried out in Rizgary Teaching Hospital and Nawroz Health Center involving 100 adult patients with essential hypertension (group I) and 100 normotensive age and gender-matched controls (group II). The serum magnesium level was measured in all participants.

Results: Females constitute 64% of both study groups. The means of the age of both study groups show no significant difference (p=0.82). Although the means of Mg level in hypertensive and control groups were within the normal range, it was significantly lower in hypertensive patients (p=0.004). Besides, 4 hypertensive patients (4%) had hypomagnesemia compared with zero in controls (p=0.043).

Conclusion: There was a significantly lower mean magnesium level in hypertensives compared to controls. A relationship was assumed between serum magnesium level and hypertension. However; hypomagnesemia was not common in hypertensive patients.

Keywords: Hypertension; Magnesium; Hypomagnesemia
Introduction

Magnesium (Mg) is the second most common intracellular cation in the human body [1]. Total body Mg is about 25 g, 60% of it is in the bones, 39% is intracellular (20% in skeletal muscle), and only 1% is in the extracellular fluid [2]. Mg is a participatory element in the build of nearly 300 enzymes in the body that adjust many biological and chemical reactions including blood pressure (BP) regulation [3]. Mg may play a pivotal role in BP regulation by many mechanisms. It can stimulate prostacyclin and nitric oxide formation [4], adjusting vasodilation [5, 6], decreasing vascular tone [7], and it can prohibit vascular injury through its antioxidant and anti-inflammatory functions [8, 9]. Considerable studies have linked between hypomagnesemia and hypertension [10].

When systolic blood pressure (SBP) is higher than 140mmHg and/or diastolic blood pressure (DBP) is higher than 90mmHg, hypertension is determined [11]. Hypertension is a common health problem worldwide. Approximately one billion adults or ~22% of the population of the world have hypertension [12]. Hypertension is regarded as an important cause of death in Iraq with a high prevalence (35.6% to 40%) [13], and a total number of nearly 7000 deaths occurred during 2015 [14].

Hypertension is considered remarkable risk factor for cardiovascular disease that can be modified [15]. Hypertension is an important accelerator of the atherosclerotic process and it frequently accompanies adult ischemic heart disease [16].

Many factors were involved in the pathogenesis of hypertension; one of them was changed in intracellular concentrations of calcium, sodium, potassium, and magnesium with an opposite correlation between serum magnesium level and occurrence of cardiovascular events [17]. Many studies have shown a relationship between low dietary intakes of magnesium with hypertension suggesting a possible effect of magnesium in the pathogenesis of hypertension [18].

No previous study was done in Erbil city concerning the same subject. Accordingly, the current study was done to estimate the levels of serum Mg in patients with essential hypertension and to evaluate the prevalence of hypomagnesemia among them, and find out any correlation between serum magnesium level and blood pressure. The present study was done among a sample of hypertensive patients versus controls in Erbil city, Iraq.

Aims and objectives:
1. To detect the serum magnesium levels in hypertensive patients.
2. To evaluate the prevalence of hypomagnesemia among them.
3. To find out any correlation between serum magnesium level and blood pressure.

Patients and Methods

This case-control study was conducted between June 2019 and December 2019 in Rizgary teaching hospital and Nawroz Health Center in Erbil city, Iraq. The study included 200 adults distributed as 100 patients with essential hypertension (group I) and 100 healthy normotensive age and gender-matched individuals as controls (group II). The inclusion criteria were adult patients...
with essential hypertension, their age ≥18 years, and of both genders. Participants with any of the following conditions were excluded: patients with secondary hypertension (diabetic nephropathy, polycystic kidney disease, and renovascular hypertension), Cushing syndrome, thyroid disease, chronic renal failure, primary hyperparathyroidism, malabsorption, osteomalacia or osteoporosis, patients taking medications like diuretics, glucocorticoids and vitamin supplements.

According to the recommendations of the 2018 ESC/ESH Guidelines for the management of arterial hypertension [11], the definition of hypertension is established when systolic blood pressure is ≥140 mmHg and diastolic blood pressure is ≥ 90 mmHg for adults aged 18 years. Blood pressure measurements were taken with a mercury sphygmomanometer, in the sitting position with the arm supported. The average of two readings was taken with a 5-minute break.

The data included in this study were age, gender, and a suitable clinical examination. A sample of the venous blood was obtained after overnight fasting from all participants to measure serum Mg level. The estimation of serum magnesium was done by an enzyme-linked immunosorbent assay (ELISA) test. According to the laboratory values, the reference range for total Mg level was 1.6-2.6 mg/dl in both male and female adults. Hypomagnesemia was considered when the magnesium level falls below 1.6 mg/dl.

**Questionnaire and data collection**

The data were collected by designing a self-administered, close-ended questionnaire, prepared for this purpose by the researcher and was filled by direct interview.

**Statistical analysis**

Data analysis was done using the statistical package for social sciences (SPSS) version 19. The results were analyzed using a t-test sample. An appropriate table was used for data representation. A P-value of ≤ 0.05 was considered statistically significant.

**Results**

As shown in Table (1), females constitute 64% of both groups with no statistically significant difference between both groups regarding gender. The means of the age of both groups show also no significant difference (p=0.82). Although the means of Mg level in hypertensive and control groups were within the normal range, it was significantly lower in hypertensive patients (p=0.004). In addition, four hypertensive patients (4%) had hypomagnesemia compared to 0% in the control group and it was statistically significant (p= 0.043).

| Table (1): Some demographics and magnesium (Mg) levels of both study groups |
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| **Group I** | **Group II** | **P value** |
| **Hypertensive patients(n=100)** | **Controls(n=100)** |
| No. | % | No. | % |
| Gender | | | | |
| Male | 36 | 36 | 36 | 36 |
| female | 64 | 64 | 64 | 64 |
| Age (years)±SD | 46.68±12.81 | 46.87±11.64 | 0.82 |
| Serum Mg (mg/dl) | 1.99±0.21 | 2.08±0.22 | 0.004 |
| Patients with hypomagnesaemia | 4 | 0 | 0 | 0.043 |
Discussion

In the present study, lower magnesium levels were detected in hypertensive patients compared to controls. Thus, this study suggests a relationship between serum magnesium levels and blood pressure in hypertensive patients. This result is in agreement with other old studies like the Uza [19] and Ma et al studies [20], as well as more recent studies done by Kanwar et al [10], Shaikh et al [21] and Champagne et al [22].

In the Uza study, which was done in 1987, serum magnesium was determined in 202 patients with essential arterial hypertension as well as in 38 normotensive control subjects. The mean value of serum magnesium was significantly lower in hypertensive patients. In 1995, Ma and his colleagues made a cross-sectional study in four US communities, in which 15,248 participants took part. The results showed that mean serum Mg levels were significantly lower in participants with hypertension. The serum Mg levels were also inversely associated with systolic blood pressure.

Kanwar and coworkers in 2011 reported a significant correlation between serum magnesium levels and hypertensive Indian patients. They mentioned that most of the hypertensive patients had low serum Mg levels. Shaikh et al found a relation between serum magnesium and blood pressure in the Pakistan population. A study by Champagne et al had shown that patients with hypertension have a marked increase in the prevalence of hypercholesterolemia, diabetes, insulin resistance and hypomagnesaemia. On the contrary, Khan et al [23], Ravi et al [24], and Maheri et al [25] studies revealed no relationship between low Mg level and hypertension.

In Khan et al study, which depends mainly on The Framingham Heart Offspring cohort study, and after eight years of follow up, found no association between baseline serum magnesium and the development of hypertension, CVD, or all-cause mortality. In Ravi et al study, there were 80 subjects with different grades of hypertension and 20 normotensive controls included, no significant difference was observed in serum magnesium levels between cases and controls. Maheri and colleagues reported nonsignificant difference was found regarding serum Mg levels when both groups were compared statistically. They concluded that there was no relation between serum magnesium level and hypertension.

Although in the current study hypomagnesemia was present in hypertensives but not in controls, it was not common. The prevalence was 4%. To the best of our knowledge, this is the first study that estimates the prevalence of Mg level in a hypertensive population in Erbil city. Our results are not compatible with the prior studies, which reported higher rates of prevalence [10, 19, 21]. In Uza study, the prevalence of hypomagnesemia detected in hypertensives was 27.72%, while it was higher in Kanwar et al study (61.25%) and in Shaikh et al study (62%). There are several causes for a lack of magnesium in the body. The main two sources for magnesium deficiency are throw the gastrointestinal tract and kidneys. Causes for hypomagnesemia include low dietary intake, diarrhea, increased urinary loss, and poor absorption.
from the intestines [26]. We excluded many causes for low Mg level in our study, yet the exact cause of hypomagnesemia in our hypertensive patients is not well explained. We think it may be multi-factorial. It may be related to low magnesium intake, or increased urinary loss of magnesium, or it may be genetically determined. Numerous experimental studies showed that low dietary intake of Mg may increase the risk of acquiring hypertension [27]. The kidneys are very efficient at maintaining body levels of Mg. However, if the diet is deficient, levels may drop. Ronghua et al, in 2009, mentioned that a mutation in mitochondrial tRNA is the cause for the hypomagnesemia linked with hypertension and dyslipidemia [28].

The magnesium levels in serum do not usually represent the precise body magnesium levels. There may be a low intracellular magnesium level even if the serum magnesium level is normal. A 24-hour urine excretion of magnesium reflects intestinal absorption and is also of value in determining whether magnesium wasting is occurring by the renal route [29]. New researches propose that urinary magnesium excretion is inversely correlated with the risk of developing hypertension [30]. The magnesium tolerance test has been used for many years and it appears to be an accurate means of assessing magnesium status. This test is a very sensitive method to detect magnesium deficiency [31, 32].

**Conclusions**

The mean Mg level was significantly lower in hypertensives compared to controls. An association is observed between serum magnesium levels and hypertension. However; hypomagnesemia is not common in hypertensive patients.

**Recommendations**

1. It is suggested that further clinical studies are proposed to clear ideas about serum magnesium levels in hypertensive patients.
2. There are controversial results regarding the effects of dietary magnesium intake and the risk of hypertension. Hence, further studies are needed before recommending this mineral supplement within the antihypertensive treatment.
3. We need to search for new and accurate methods to assess magnesium status. It has been proposed that the measurement of serum total magnesium and the magnesium tolerance test are the simplest, most useful and readily available tests to detect hypomagnesemia.

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**Ethical clearance:** An ethical approval was obtained from the Ethics Committee of the College of Medicine at Hawler Medical University. A verbal consent was obtained from all participants in this study. The aim of the study was illustrated to the patients.

**Conflict of interest:** The author stated no opposition of interest.

**Limitations**

1. The small sample size was one of the limitations of this study. Therefore, a larger sample size would help clarify a more statistically precise conclusion.
2. Since Magnesium is an intracellular ion, normal serum Mg levels do not reveal intracellular magnesium deficiency. As a result, intracellular Mg concentration is more significant than serum Mg concentration. As
intracellular electrolyte estimation tests are costly, they are not easily obtainable and difficult for clinical application. Accordingly, serum Mg levels are used for detecting changes in body Mg concentration.

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