Serum concentrations of magnesium among Jordanians: Effect of cardiovascular disease on magnesium levels

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ABSTRACT

Magnesium plays a role in a number of enzymatic reactions such as; it fulfils various intracellular physiological functions. Therefore, irregularity in magnesium status-mainly hypomagnesaemia as it is seen more often than hypomagnesaemia—might result in unwanted neuromuscular, cardiac or nervous disorders. Measuring total serum magnesium is a practical and affordable way to monitor changes in magnesium status, although it does not necessarily reflect total body magnesium content. To date, no group has evaluated magnesium as a cardiovascular risk factor in Jordanian population. Thus, a simple colorimetric method (Xylidyl blue method), was used to determine the magnesium serum levels in a population of healthy and patients from Jordan Hospital. 151 subjects were enrolled in this study (101 healthy and 50 patients). There was a decrease but non-significant (p>0.05) in Mg levels in patients samples compared to that of healthy (2.01±0.28 vs. 2.04±0.18, respectively). Our findings indicate that we could not prove a correlation between Mg serum levels and cardiovascular diseases among Jordanian patients. Similarly, no effect for gender or smoking magnesium levels.

Key words: Magnesium, Cardiovascular Disease, Smokers, Jordanian

INTRODUCTION

Electrolytes are minerals found in blood and other body fluids; they carry an electric charge, and affect the amount of water in body, pH of the blood, muscle functions, and other essential processes[1, 2]. The main electrolytes found in the serum are sodium (Na⁺), potassium (K⁺), calcium (Ca²⁺) and magnesium (Mg²⁺)[3, 4]. These electrolytes have an important role in metabolism and cellular functions, including enzyme activities and electrical gradients[4, 5]. Magnesium (Mg) is the second most abundant intracellular cation and the fourth most abundant cation in the body[6, 7]. Magnesium have many important physiological roles in the body. These roles are achieved by two important properties of magnesium; the ability to form chelates with important intracellular anionic-ligands, especially ATP, and its ability to compete with calcium for binding sites on proteins and membranes[8, 9].

In addition, Mg have role in the synthesis of nucleic acids and proteins, being part of the intermediary metabolism and essential in specific actions in different organs like neuromuscular and cardiovascular systems, and over 300 enzymes are dependent on it[8,10].
About 99% of total body magnesium is located in bone, muscles and non-muscular soft tissue. Approximately 50–60% of magnesium resides as surface substituents of the hydroxyapatite mineral component of bone. Most of the remaining magnesium is contained in skeletal muscle and soft tissue[9, 10]. The magnesium content of bone decreases with age, and magnesium stored in this way is not completely bioavailable during magnesium deprivation. Nonetheless, bone provides a large exchangeable pool to buffer acute changes in serum magnesium concentration. Overall, one third of skeletal magnesium is exchangeable, serving as a reservoir for maintaining physiological extracellular magnesium levels[8, 10, 11].

Magnesium deficiency, or hypomagnesaemia, is frequently undetected in patients, and recent studies are showing that it’s present more than previously thought[9, 12]. This is mainly due to that hypomagnesaemia being asymptomatic, or being a secondary symptom for an ongoing condition. Signs and symptoms of magnesium deficiency are usually not seen until serum magnesium decreases to 0.5 mmol/L or lower [7, 8,13].

Traditionally, general level of magnesium in blood serum is analyzed by colorimetric, potentiometric and atomic-absorption spectrometry (AAS) methods[14].

Thus, Mg may protect the cardiac cells from the effects of coronary artery disease (CAD) and improve the cells ability to resist its effect, and an increased intake of dietary Mg can offer protection against cardiovascular deaths[15].

Furthermore, some studies find no difference in Mg levels between hypertension patients and healthy people[14]. This indicates that not all personnel with hypomagnesaemia suffer from hypertonension, and that there are other factors that may affect the correlation between Mg and hypertension, such as obesity, diabetes, pregnancy, race, and others[11].

Oppositely, some studies have established that there is a reverse relationship between Mg level and blood pressure. And the exact mechanism of Mg role in the pathogenesis of hypertension is not clear[16].

The aim of this study is to find the relation between the Mg serum levels and cardiovascular patients in volunteers living in Jordan, and to examine the effect of sex and smoking on Mg status.

**EXPERIMENTAL SECTION**

2.1 Clinical part
2.1.1 Study population
The blood sampling from 151 subjects was conducted between September and November, 2014, from cardiovascular diseases patients and healthy volunteers. The experiment population is (n=151) subject, include healthy(n=101) and CVD patients (n=50). The subjects were randomly picked and signed the case report form before participation. The study case report form was approved by Jordan Center of Pharmaceutical Institution Review Board / Independent Ethics Committee.

Before collecting samples, many questions and information had been collected by self-reporting from volunteers using case report form, and then classified according to study requirements as shown in table 1.

<table>
<thead>
<tr>
<th>Table 1: Age of the study population</th>
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<tbody>
<tr>
<td><strong>Healthy Volunteers</strong></td>
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<tr>
<td><strong>Mean ± SD</strong></td>
</tr>
<tr>
<td><strong>Total Participants</strong></td>
</tr>
<tr>
<td><strong>Male</strong></td>
</tr>
<tr>
<td><strong>Female</strong></td>
</tr>
<tr>
<td><strong>Smokers</strong></td>
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<tr>
<td><strong>Non-Smokers</strong></td>
</tr>
</tbody>
</table>

2.1.2 Blood sampling
Blood samples of 5 ml were drawn by trained nurse, collected in plane tubes, stand for clotting for 5-10 minutes and then centrifuged at 5000 rpm for 5 minutes, then serum was collected and stored at -70℃ until analysis.
2.2 Magnesium analysis
Quantitative analysis of magnesium in human serum is conducted using Xyldyl Blue-I Method. A Magnesium kit was used (Mindray Bio-Medical Electronics Co., Ltd, China). Mg serum samples were analyzed according to the manufacturer procedures. Briefly, collected samples were centrifuged before the assay, to get rid of any possible precipitates, then 10µl mixed thoroughly with 1ml reagent, at 37°C. The reagent is a combination of xyldyl blue 0.1mM, EGTA 0.13mM,DMSO 1.4M, Buffer, and surfactants. EGTA is used to eliminate calcium interference, while the surfactant system is included to remove protein interference. A blank was prepared by mixing 10µl distilled water with 1ml reagent. The absorbance was read five minutes after the sample preparations, using Mindray BS 200 chemical analyzer (Mindray Bio-Medical Electronics Co., Ltd, China).

2.3 Data analysis
Data were expressed as Mean ± SD. Comparisons of variables were assessed by using t-test using SPSS (version 19.0). P value of <0.05 is considered statistically significant. Mg normal serum level was set as (1.5 to 2.4 mg/dL)

RESULTS AND DISCUSSION

3.1 Mg analysis and distribution
A total of 151 person participated in the study. Of these, 101 person were healthy (34% males, 66% females), and 50 patient (54% males, 46% females). Healthy participants ranged from 18 to 42, with an average of 21.5 ± 3.8 years, while patient participants ranged from 20 to 89, with an average of 63.14 ± 13.73 years.

The mean of Mg serum levels in the study population, healthy and patient subjects, was within the normal range (1.5 to 2.4 mg/dL) (Table 2). All the healthy population Mg serum levels was within the normal range, while the patient population have 5% about the normal range. No significant difference was found between healthy and patient subjects, with Mg serum levels of healthy subjects showed low elevation compared to patient Mg serum levels.

<table>
<thead>
<tr>
<th>Healthy Statistics</th>
<th>Patients Statistics</th>
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<tbody>
<tr>
<td>N</td>
<td>Mean ± STD</td>
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<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
</tr>
<tr>
<td>Males</td>
<td>37</td>
</tr>
<tr>
<td>Females</td>
<td>64</td>
</tr>
<tr>
<td>Smokers</td>
<td>15</td>
</tr>
<tr>
<td>Non-Smokers</td>
<td>86</td>
</tr>
</tbody>
</table>

3.2 Gender effect on Mg levels
No significant (p>0.05) effect for subject sex on the Mg serum levels. Both males and females, healthy or patient, have Mg serum levels within the normal range, and without any significant differences between healthy and patient subjects (figure 1).

Mg serum levels of patient males showed low elevation compared to healthy males Mg serum levels (Cohen’s d= -0.09435). While Mg serum levels of healthy females showed medium elevation compared to patient females Mg serum levels (Cohen’s d= 0.2651).

3.3 Smoking effect on Mg levels
Smoking showed no significant effect on the Mg serum levels. Both smokers and non-smoker, healthy or patient, have Mg serum levels within the normal range, and without any significant differences between healthy and patient subjects (figure 1).

Mg serum levels of patient smokers showed medium elevation compared to healthy smokers Mg serum levels (Cohen's d= -0.2408). While Mg serum levels of healthy non-smoker showed small elevation compared to healthy non-smoker Mg serum levels (Cohen's d= 0.2651).
Mg role in CVD has been studied for the past decades, and several researchers indicated a correlation between low serum Mg and CVD, especially in ischemic heart disease (IHD) and some type’s arrhythmia[17]. Yet in our study, there was no significant difference between Mg serum levels in patients and healthy subjects, with the mean of both groups relay in the normal range. Further on, there was no correlation between Mg level and sex or smoking. Similarly, Khatami et al., found that there was no correlation between Mg serum levels and CVDs risk factors in hemodialysis patients[18].

The findings of current study can be related to the Jordanian dietary intake of Mg, which is believed to be slightly below the recommended daily intake[19]. This might indicate that the Mg intake levels within the Jordanian community are sufficient enough to prevent hypomagnesemia.

We hypothesize that low Mg serum levels caused by low intake of dietary Mg, might be a leading cause or a risk factor for a CVD, but not necessary a symptom for an existing CVD condition. This has been previously implied in a follow up studies, were low Mg serum levels predicted future CV complications[20, 21].

CONCLUSION

Magnesium appears within the normal range among Jordanian people, sex and smoking did not affect the magnesium levels in those populations. Some factors like number of subject participate in this study, the distribution of the subjects according to the numbers and sex, and the diet consumption by participants may affect the result of the study. Further studies investigating the role of Mg in CVD is required, to establish the correlation between Mg and the specific types of cardiovascular diseases.

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REFERENCES