Assessment of serum ionized magnesium levels in healthy volunteers, in patients with coronary artery disease and/or hypertension and in hypertension alone

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Abstract. We examined ionized magnesium concentration by blood analysis in patients with hypertonia arterialis, ischemic heart diseases, both of them and in a control group. Slightly lower mean serum ionized magnesium concentration was found in the study group hypertonia arterialis when compared to the control group. In patients both group “B” with coronary artery diseases and group “C” with hypertonia arterialis + ischemic heart diseases, mean serum ionized magnesium concentrations were higher than in the control group, the differences were statistically significant.

Key words: ionized magnesium, hypertension, ischemic heart disease

Magnesium is one of the most significant elements necessary for the proper function of the human body. Like potassium it is an intracellular cation. Magnesium takes part in the majority of metabolic and energetic processes as an activator and co-factor of more than 300 enzymes. Magnesium also influences the other electrolyte concentrations acting through the calcium and sodium-potassium pump. In the human body magnesium is found mainly within the intracellular space. Only approximately 1% of the general magnesium pool is found in the extracellular fluids [5]. Ionized fraction is a biologically active form of magnesium that constitutes ca 60-80% of the serum magnesium concentration. The function of the organism is best described by the ionized fraction that is the active pool of the bioelements [13, 16]. Magnesium deficiency is best documented in severe diseases and acute life-threatening states in patients treated in gynecology, cardiosurgery and intensive care. Correction of the magnesium deficiency is one of the life-saving procedures performed in these patients [3, 8, 10, 17]. Because of the well recognized, significant role of magnesium in the human body new research on chronic diseases that afflict modern society is
needed. The aim of the study was to evaluate the ionized fraction of serum magnesium in patients with circulatory system abnormalities: arterial hypertension and stable coronary disease.

**Material and methods**

The study enrolled 437 ambulatory patients referred for routine check-up in the chosen period of 4 months. Review of the patient's history, physical examination and analysis of medical files were performed in all patients with special regard to the risk of disease of circulatory system and other coexisting diseases. The study group enrolled 113 individuals with diagnosed arterial hypertension, 26 individuals with diagnosed stable coronary artery disease, and 25 individuals with diagnosed arterial hypertension and coexisting coronary artery disease.

All patients from the study group had ECG, funduscopy, lipid and carbohydrate metabolism checked during the few past months. The patients with diagnosed diabetes mellitus, lipid disturbances, thyroid gland function disturbances and patients taking magnesium preparations and individuals on any type of diet were excluded from the study. Only individuals with BMI ranging from 20 to 30 were enrolled into the study.

Group A comprised 113 patients with WHO I° or II° arterial hypertension without any coexisting diseases; 68 patients in that group were treated with ACE inhibitors, 23- with beta-blockers, and 22- with calcium channel blockers as monotherapy.

Group B comprised of 26 patients with a positive history, ECG and exercise ECG findings, USG for coronary artery disease, with I° or II° degree of chest pain, without any additional diseases. Patients with cardiac infarction and circulatory failure were excluded from the examined group. The following medications were administered in that group: 8 patients had beta-blockers combined with nitrates, 14 patients had beta-blockers as monotherapy, and 4 patients had calcium channel blockers combined with nitrates. In addition, 24 patients in that group had acetylsalicylic acid and 2 had ticlopidine.

Group C comprised of 25 patients with stable coronary artery disease (I° and II° CCS) with coexisting arterial hypertension (WHO I° and II°). The diagnostic criteria for these diseases were the same as applied in groups A and B. 18 patients received ACE inhibitor agents and beta-blockers, 7–ACE inhibitor and calcium channel blockers. All patients were administered acetylsalicylic acid.

Group D comprised of 273 individuals seen around the same time, most frequently for a routine check-up required for employment purposes. Arterial hypertension, ischemic disease of the heart, diabetes mellitus, other endocrinologic diseases and renal failure were excluded, based on physical examination and medical files in patients from that group. These individuals did not take any drugs or other preparations containing magnesium. They were on a standard diet without any dietary restrictions.

Patients fasted before blood sampling for at least 8 hours. Blood samples were collected from the ulnar vein using the Vacuum syringes. The serum concentration of the ionized magnesium (iMg) was evaluated immediately after centrifugation in order to diminish the influence of increasing pH on ionized magnesium concentration. The measurements were performed using AVL 988-4 apparatus equipped with an ion selective magnesium electrode.

The data obtained underwent statistical analysis using Statistica PL software. Evaluation of quantitative variables included analysis of minimum, maximum, arithmetic mean, median and standard deviation. The distribution of all qualitative parameters was tested using the Shapiro-Wilk test and homogeneity was tested using Levene’s test. The Kruskal-Wallis test was used to evaluate the significance of differences because the distribution was not normal. The level of significance was p < 0.05.

**Results**

The results are shown in table 1. It contains serum ionized magnesium concentrations in the groups studied and in the control group. The results obtained indicate moderate, statistically insignificant differences in mean serum magnesium concentrations in the groups analysed when compared to the results obtained in controls (Kruskal-Wallis test).

**Discussion**

In the world literature there are numerous reports on dismagnesemia in circulatory system diseases [12, 14, 20, 21] Dacey found decreased concentrations of ionised magnesium in the serum of individuals with both ventricular and supraventricular arrhythmias [4]. Sasaki et al. confirmed these findings and emphasised the presence of increased magnesium concentrations in erythrocytes in patients with arterial hypertension and normal serum magnesium levels [18].

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Touyz in his report stated that magnesium played an important role in the pathogenesis of hypertension; however, any information on application of that element in therapy frequently was confusing [21].

Jee et al. [9] conducted a meta-analysis of clinical trials on application of magnesium in treatment of arterial hypertension and concluded that the influence of magnesium supplementation on lowering of arterial hypertension was minimal; however, they also stated the positive correlation between high magnesium intake and biggest drop in arterial blood pressure.

In our studies we evaluated the concentrations of ionised magnesium in hypertensive patients. The concentrations of ionised magnesium in hypertensive patients and in controls did not differ significantly.

Similar conclusions were found by Kosch et al. They compared serum magnesium concentrations in 39 patients with arterial hypertension and 40 with normal blood pressure. They found the following serum magnesium concentrations in the analysed groups: 0.87 mmol/L and 0.83 mmol/L, respectively [11].

Resnick et al. found statistically a significantly lower level of serum ionised magnesium in hypertensive patients not treated pharmacologically compared with healthy individuals. The differences were more distinct in Caucasians (0.579 hypertensive versus 0.620 healthy controls). The ionised to non-ionised magnesium ratio was increased in both studied black patient groups (with and without arterial hypertension) and in hypertensive Caucasians. The results cited indicate disturbances in calcium and magnesium regulation – most likely both the cause and the result of the disease. It is worth mentioning that the blood pressure values did not influence the changes in magnesium levels [15].

When analysing the above mentioned data one should underline the prevalence of sodium-dependent arterial hypertension among black hypertensive patients. Evaluation of the concentration of ionised magnesium associated with sodium-dependent arterial hypertension requires further studies.

Numerous data from the literature indicate the significant role of hypomagnesemia in the development of coronary artery disease and the possibility of risk reduction for CAD by magnesium supplementation [1, 2]. Researchers e.g. Ueshima et al., Guo, Elming et al. underline in their papers that the concentration of total and ionised magnesium is lower in patients with acute ischemia of the heart when compared to concentrations of that element in healthy individuals [6, 7, 22].

The mean serum ionised magnesium concentration obtained in our research of patients with coronary artery disease was higher than in the control group; however, the differences were not statistically significant.

Confusing data on the benefits from magnesium supplementation in the treatment of coronary artery disease, underlined also by Schechter et al. indicate the need for further studies [19].

Conclusion

The highest differences in serum concentrations of ionized magnesium were found between healthy controls and patients with arterial hypertension coexisting with coronary artery disease. However, these differences were not statistically significant.

References


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