Serum Magnesium Concentration in Children with Asthma

Nevin Hatipoğlu[1], Hüsem Hatipoğlu[1], Özden Türel[2], Çiğdem Aydoğmuş[1], Nuri Engerek[1], Serdar Erkal[3], Rengin Şiraneci[1]

[1]Clinic of Peditrics, Kanuni Sultan Süleyman Education and Research Hospital, İstanbul
[2]Department of Pediatrics, Bezmialem Vakif University Faculty of Medicine, İstanbul
[3]Biochemistry Laboratory, Kanuni Sultan Süleyman Education and Research Hospital, İstanbul

Abstract

Objective: Asthma is the most common chronic disease of childhood, and magnesium is one of the most frequently found minerals in human body and it is used in the treatment of asthma. Although there are studies on magnesium levels in adult patients with asthma, there is yet no data on the levels of magnesium in children. The present study compared the levels of serum magnesium between the children with asthma and healthy children.

Methods: Children aged between 5 and 17 years with mild-moderate persistent asthma, who were admitted to our hospital between January 2009 and August 2010, were included in the study. Serum magnesium levels were measured in 50 patients with acute asthma attack, in 50 patients receiving treatment for stable asthma, and in 50 children admitted to the hospital for any reason and matched with asthma patients except for the diagnosis of asthma. The test was performed by photometric method using Roche-Hitachi Modular P biochemistry analyzer. The normal range of serum Mg was considered to be 1.59-to-2.10 mg/dL and $p<0.05$ was considered statistically significant.

Results: All three groups were similar in terms of mean age and gender distribution. Although mean serum magnesium levels were within the normal range in healthy children and in children treated for stable asthma (1.89±0.32 and 1.93±0.34 mg/dL respectively), it was 1.62±0.26 mg/dL in children having an asthma attack, which was within the normal range but close to the lower limit ($p<0.001$).

Conclusion: Although its efficacy has not been definitely proven, magnesium is used either via intravenous route or as inhaler in acute asthma attack. Knowledge about the changes in body magnesium levels of asthma patients would be a guide for revealing the role of magnesium in the treatment of asthma. As was shown in the present study, magnesium levels tend to decrease in the body during acute attack.

Keywords: Asthma, children, magnesium level

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Address for correspondence
Nevin Hatipoğlu, Clinic of Peditrics, Kanuni Sultan Süleyman Education and Research Hospital, İstanbul, Turkey
E-mail: naydin9@mynet.com

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INTRODUCTION

Asthma is the most prevalent chronic disease of childhood. Worldwide, 300 million people have been reported to have asthma, and the mean prevalence of asthma is 7.4% in Turkey (1). The prevalence of physician-diagnosed asthma among Turkish children is reported to range between 5% and 16.4% (2-7). Öneş et al. (8) stated that prevalence of asthma in children is 9.8% in Istanbul.

Magnesium (Mg) is the fourth most abundant ion in the human body; of which 50% is stored in the bones, 49% in cells and the remaining 1% in the serum. It is involved in the structure of many enzymes in the body and plays a role in intracellular reactions. It is used in the treatment of acute asthma attack owing to its bronchodilator effect, by reversing bronchospasm.

Serum Mg levels have been investigated in adult patients with asthma; whilst some studies found Mg levels to be low in these patients, some studies did not corroborate these findings (9-11). In Turkey, studies on Mg levels in patients with asthma include adult patients (12,13). To the best of our knowledge, no national study investigating Mg levels in children with asthma have been published yet.

Table 1. Comparison of the parameters of the study groups

Parameter	Study groups (mean±SD)			p value
	Group 1 (acute attack)	Group 2 (stable asthma)	Group 3 (control)	
Patient number	50	50	50	
Gender (male)*	31	28	24	0.369
Age (years) (mean±SD)+	8.2±3.3	9.1±2.8	8.6±3.7	0.393
Serum magnesium level (mg/dL)+	1.62±0.26	1.89±0.32	1.93±0.34	0.001
*Chi-square test; +One way analysis of variance				

In this present prospective study serum magnesium levels both in children with acute asthma attack and in children followed up for stable asthma were measured and compared with Mg levels in healthy children with matching characteristics.

METHODS

Children aged between 5 and 17 years with mild to moderate persistent asthma who were admitted to the pediatrics clinic of our hospital between January 2009 and August 2010, were included in the study. Patients that presented with acute asthma attack were assigned to Group 1 and patients with no acute asthma attack in the last 4 weeks and followed in an ambulatory setting with the diagnosis of stable asthma were assigned to Group 2. Diagnosis of asthma and severity of disease were identified based on the Global Initiative for Asthma (GINA) guideline criteria (14). Patients with any other chronic pulmonary disease or infection, with cardiac, renal or endocrine disorder, receiving Mg-containing drugs, with malnutrition or pregnancy, or who refused to participate in the study were excluded from the study. Children who were admitted to the hospital for other reasons and matched with the patients in the other study groups in terms of other characteristics than asthma were assigned to Group 3 (control group). The study was carried out in line with the Helsinki Declaration (15) after obtaining approval from the Ethics committee of our hospital. The written consent of the parents or legal representatives of the patients were obtained.

A detailed anamnesis was taken from all patients and they underwent complete physical examination. Venous blood samples were obtained under standard conditions for the measurement of serum Mg levels. Hemolyzed blood samples were not included in the analysis. The test was performed by photometric method using Roche-Hitachi Modular P biochemistry analyzer (Roche/Hitachi Modular P Chemistry Analyzer; Roche, Minnesota, USA). The normal range of serum Mg levels was considered to be 1.59-to-2.10 mg/dL.

Statistical Analysis

Statistical analysis was performed using NCSS (Number Cruncher Statistical System) 2007 Statistical Software (Utah, USA) package program. In addition to descriptive statistical methods (mean, standard deviation), data were evaluated using one-way analysis of variance for intergroup comparisons, using Tukey multi-comparison test for the comparison of subgroups, and using Chi-square test for the comparison of qualitative data. A p value <0.05 was considered significant.

RESULTS

Each group consisted of 50 patients. No statistically significant difference was observed between Group 1 (acute asthma attack), Group 2 (stable asthma) and Group 3 (control group) in terms of gender distribution (p=0.369) and mean age (p=0.393). Patients in Group 1 and Group 2 were similar in terms of disease severity and the types of treatment for chronic asthma.

Table 2. Comparison of serum magnesium levels between patient groups

Tukey Multiple comparison test	p
Group 1 / Group 2	0.001
Group 1/ Group 3	0.001
Group 2 / Group 3	0.546

Mean serum magnesium levels were 1.62±0.26 mg/dL, 1.89±0.32 mg/dL and 1.93±0.34 mg/dL for Group1, 2 and 3, respectively (Table 1). There was a significant difference between mean serum magnesium levels (mg/dL) of Group 1, Group 2 and Group 3 (p=0.001). While mean serum magnesium level (mg/dL) was significantly lower in Group 1 versus Group 2 and Group 3 (p=0.001), no statistically significant difference was found between serum magnesium levels (mg/dL) of Group 2 and Group 3 (p=0.546) (Table 2).

DISCUSSION

It is reported that asthma, which is a chronic airway disease, is gradually becoming more prevalent both in adults and in children (1). Acute attacks rank first among children in terms of emergency room admissions, and improper monitoring leads to high number of missed school days. In chronic treatment, mineral-supplementation therapies, such as magnesium, are being tried in addition to the given standard treatments. Improvement in bronchial responsiveness and quality of life were reported with oral magnesium therapy in adult patients with asthma (16). Similar effects have also been demonstrated in children (17,18).

Magnesium is the cofactor of more than 300 enzymes and is involved in many physiological functions including protein synthesis, intracellular signal distribution and enzyme catalysis (19). Since it is the natural antagonist of calcium, it provides smooth muscle relaxation (20). This effect has been demonstrated in the *in vitro* models of the bronchial wall and in asthmatic airways in vivo (21,22). In addition, magnesium suppresses the excitability of muscle fibers by reduction of acetylcholine secretion from motor nerve terminals. Moreover, it inhibits production of inflammatory mediators by helping stabilization of T-cells and inhibiting mast cell degranulation. Again, it reduces the severity of inflammation in asthma by stimulating nitric oxide and prostacyclin syntheses.

Based on these effects, Mg is being used for years in the treatment of acute attacks in adult patients with asthma (23); however, contradictory results have been obtained about its efficacy. In the studies reported from Turkey, Mg therapy via nebulizer or intravenous route was not found beneficial in adult patients with acute asthma attacks (24,25).

Magnesium has also been tried for the treatment of acute asthma in children (26). Meral et al. (27) conducted a study in children with acute asthma attack and gave magnesium sulphate to 20 patients and inhaled salbutamol sulphate to another 20 patients and found that magnesium sulphate showed a bronchodilator effect, but this effect was short-term. Gürkan et al. (28), who investigated the effects of intravenous magnesium sulphate in children with moderate-to-severe acute asthma attack refractory to conventional treatment, demonstrated that treatment improved the clinical status and the peak expiratory flow rate.

Serum levels of magnesium have been investigated in asthmatic patients based on its effects in asthma treatment. Low serum Mg levels in adult asthmatic patients have been described many years ago (9,29). Contrarily, some studies reported no difference between asthmatic patients and normal individuals, in terms of serum magnesium levels (10,11). In Turkey, Deveci et al. (13) measured serum electrolytes in adults receiving chronic asthma treatment and determined hypomagnesaemia in 56.6% of patients. Gönlügür et al. (12) obtained similar results in patients with acute asthma.

In a recently reported Cochrane meta-analysis, it was demonstrated that inhaled magnesium cannot be an alternative for beta-agonist therapy in acute asthma and is not superior in terms of reduction in the number of hospitalizations, but may be beneficial in the improvement of pulmonary functions in severe asthma exacerbation (30).

Although it has been a subject of research in adults for a long time, serum Mg levels of children has recently begun to be investigated. First, Kakish et al. (31) reported that serum Mg levels were not lower during and between attacks in asthmatic children aged between 6 and 18 years as compared to the control group without asthma.

In this present study, we as well found that serum Mg levels were within the normal range in both patient groups including children with acute asthma attack and with stable asthma. However, although it was within the normal range, serum magnesium levels were statistically significantly lower in patients with asthma attack versus the other groups.

Magnesium is mainly an intracellular ion and normal serum Mg levels may not reflect intracellular magnesium deficiency. Therefore, it is emphasized that intracellular Mg concentration is more important than serum Mg concentration (32,33). In the studies, in which intra-erythrocyte/leukocyte and serum Mg concentrations were measured in adult asthmatic patients, results were found to be within the normal range both in asthmatic and non-asthmatic patients. This was attributed to the asthma attack being mild (10,34).

Studies performed on the measurement of intra-erythrocyte Mg concentrations in children are limited. Sedighi et al. (35) found that intra-erythrocyte Mg concentrations were low in 27 children with acute asthma despite normal plasma levels. This situation during asthma attack was explained as the result rather than the cause of bronchospasm. In a recent study conducted in 30 children with acute asthma attack, plasma Mg levels were normal but erythrocyte magnesium concentration was low, and it was demonstrated that erythrocyte Mg concentration significantly increased after treatment of the acute attack and there was a negative correlation between erythrocyte Mg concentration and the severity of the attack (36). In 26 children aged between 3 and 14 years, who were being followed up for intermittent asthma, an increase was observed in plasma and leukocyte Mg concentrations during acute attack after 5-days treatment (37).

As is seen, all these studies on intracellular Mg measurement have been done in a limited number of patients. As intracellular electrolyte measurement tests are expensive, they are not easily available and difficult for clinical application (29). Therefore, generally serum Mg levels are used for the monitoring of changes in body Mg concentration during acute attack and stable phases of asthma. In the present study, serum Mg levels were measured because of the facts that intracellular magnesium is not measured in our unit and there is yet no available study on this subject in Turkey.

CONCLUSION

Benefits of magnesium in the treatment of asthma have not been clearly established yet. However, understanding Mg homeostasis of the body is essential for Mg to be included in definite recommendations as supportive treatment in childhood asthma. Asthma is common among children in Turkey and data on Mg levels are inadequate in this patient group. According to the present study, Mg levels are at least at the lower levels in children with acute asthma. Studies that would be performed in larger patient groups of children with asthma using more advanced testing methods are needed.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Kanuni Sultan Süleyman Education and Research Hospital.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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