Assessment of relationship between serum magnesium and serum glucose levels and HOMA-IR in diabetic and prediabetic patients

Diyabetik ve prediabetik hastalarda serum magnezyum ve serum glukoz düzeyleri ile HOMA-IR arasındaki ilişkinin değerlendirilmesi

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Abstract

Aim: In this study, we aimed to investigate the serum magnesium (Mg) levels in diabetic and prediabetic patients and its correlation with age, body-mass index, HOMA-IR, serum fasting glucose, HbA1c, and insulin levels.

Methods: In this retrospective study, a total of 130 patients consisted of newly diagnosed prediabetes (Group PD) (n=63) and type 2 diabetes mellitus (Group D) (n=67) were included. Patients' age, body mass index, serum Mg, glucose and insulin, HOMA-IR and HbA1c were recorded. The prediabetes and type 2 diabetes diagnoses had been made according to WHO criteria at the time of diagnosis.

Results: In group D, the mean Mg level (1.88 ± 0.17 mg/dl) was significantly lower than group PD (1.96 ± 0.17 mg/dl) (p = 0.007). Correlation analysis showed that there was a significant negative correlation between Mg and glucose (r = -0.390, p = 0.001) and HOMA-IR (r = -0.284; p = 0.022) in the group D. No correlation was found between serum Mg level and serum insulin, HbA1c, age, and body-mass index (p = 0.801, 0.087, 0.611 and 0.691, respectively). In group PD, serum insulin, HbA1c, glucose, HOMA-IR, age, and body-mass index were not corraleted with serum Mg levels (p = 0.801, 0.087, 0.939, 0.998, 0.611 and 0.691, respectively).

Conclusıon: We showed that while there was a negative correlation between magnesium levels and HOMA-IR and fasting blood glucose levels in diabetic patients, but this correlation was not present in prediabetic patients. Our results suggest that serum Mg level is associated with metabolic control of type 2 diabetes and thus it can be considered in these patients.

Key words: Magnesium, diabetes, prediabetes, insülin resistance, fasting glucose, HOMA-IR

Öz

Amaç: Bu çalışmada diyabetik ve prediyabetik hastalarda serum magnezyum (Mg) düzeyleri ile yaş, vücut kitle indeksi, HOMA-IR, serum açlık glukoz, HbA1c ve insülin düzeyleri arasındaki ilişkiyi inceledik.

Yöntemler: Bu retrospektif çalışmada, yeni tanı almış prediyabet (Grup PD) (n=63) ve tip 2 diabetes mellitus (Grup D) (n=67) olmak üzere toplam 130 hasta çalışmaya alındı. Hastaların yaşı, vücut kitle indeksi, serum Mg, glukoz ve insülin değerleri, HOMA-IR ve HbA1c kaydedildi. Prediabetes ve tip 2 diyabet tanısı, tanı anında WHO kriterlerine göre yapıldı.

Bulgular: Grup D'de ortalama Mg düzeyi (1,88 ± 0,17 mg/dl), grup PD'den (1,96 ± 0,17 mg/dl) anlamlı derecede düşüktü (p = 0,007). Korelasyon analizi, D grubunda Mg ve glukoz (r = -0,390, p = 0,001) ve HOMA-IR (r = -0,284; p = 0,022) arasında anlamlı negatif korelasyon olduğunu gösterdi. Serum Mg ile insülin, HbA1c, yaş ve vücut kütle indeksi (sırasıyla p = 0,801, 0,087, 0,611 ve 0,691) arasında korelasyon saptanmadı. Grup PD'de serum insülin, HbA1c, glukoz, HOMA-IR, yaş ve vücut kitle indeksi ile serum Mg düzeyleri arasında korelasyon yoktu (sırasıyla p = 0,801, 0,087, 0,939, 0,998, 0,611 ve 0,691).

Sonuçlar: Diyabetik hastalarda magnezyum düzeyleri ile HOMA-IR ve açlık kan glikoz düzeyleri arasında negatif bir ilişki olduğunu, ancak bu ilişkinin prediyabetik hastalarda mevcut olmadığını gösterdik. Çalışma sonuçlarımız serum Mg seviyesinin tip 2 diyabetin metabolik kontrolü ile ilişkili olduğunu ve bu nedenle bu hastalarda göz önüne alınabileceğini düşündürmektedir.

Anahtar Kelimeler: Magnezyum, diyabet, prediyabet, insülin direnci, açlık glikoz, HOMA-IR

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Introduction

Magnesium (Mg) is the second most abundant intracellular cation after potassium present in living cells and may influence the regulation of blood glucose metabolism by modulation of insulin secretion and insulin action [1]. Therefore, alterations in the metabolism of this mineral may influence these functions, contributing to the pathogenesis of obesity and insulin resistance [2, 3].

Studies and knowledge on the relationship between diabetes and Mg status are expanding. Hypomagnesemia is a common finding in type 2 diabetic patients (T2DM) [4]. It has been reported to occur in 13.5 to 47.7% of patients with T2DM compared with 2.5 to 15% among their counterparts without diabetes [5-8]. Some studies have demonstrated the action of Mg on insulin resistance in obesity and diabetes, and thus Mg deficiency has been proposed as a risk factor for T2DM [1, 9, 10].

Prediabetes, characterized by impaired fasting glucose and/or impaired glucose tolerance, is considered an important risk factor for the development of overt diabetes [11]. A few studies have investigated the association of serum Mg levels with prediabetes, but the findings were inconsistent [3, 12]

In this study, we have aimed to investigate the serum Mg levels in patients with T2DM and prediabetes and its correlation with serum fasting glucose, insulin, HOMA-IR (Homeostatic Model Assessment for Insulin Resistance) and HbA1c levels.

Material and methods

In this retrospective study, patients with newly diagnosed prediabetes and T2DM who were admitted to Diabetes and Internal Medicine outpatient clinics of Bakirkoy Dr. Sadi Konuk Education and Research Hospital between February 2017 and January 2018 were evaluated. The study was approved by institutional ethical committee of the Bakirkoy Dr. Sadi Konuk Education and Research Hospital (2018/144), which complies with Helsinki Declaration.

A total of 130 patients with prediabetes and T2DM were included in this study. The study included 67 newly diagnosed T2DM (group D) and 63 newly diagnosed prediabetic patients (group PD). All patients were newly diagnosed patients and have not reported a history of diabetes and not used insulin or an oral antidiabetic agent at the time of diagnosis. At our outpatient clinics the prediabetes and T2DM diagnoses have been made according to WHO criteria [13].

Exclusion criterias were as follows: patients other than newly diagnosed diabetes and/or prediabetes; patients with hypertension, chronic renal failure, acute or chronic diarrhea, malabsorption syndrome, congenital diseases, immunologic diseases, acute/chronic pancreatitis, cirrhosis, malignancy, epilepsy and patients who were using alcohol, magnesium-containing antacids, magnesium-containing vitamin-mineral preparations.

Patients' age, weight, height, glucose, insulin, HOMA-IR, glycosylated hemoglobin (HbA1c), calcium (Ca), Mg, and 25 (OH) vitamin-D levels were recorded. Body mass indexes (BMI) [(weight (kg) / height (m²)] of all patients were calculated using height and weight measurements. HOMA-IR was measured to determine insulin resistance and calculated as the fasting insulin level (μU/mL) × early morning fasting blood glucose level (mg/dL)/405. In our clinical routine, blood samples were taken in the morning after at least 12 hours of nightly fasting.

Statistical analysis

For the statistical analysis, SPSS version 17 for Windows (Statistical Package for Social Sciences - SPSS, Chicago, IL, USA) was used. Student t test was used for comparison of descriptive statistical methods (mean and standard deviation) as well as quantitative data when study data were evaluated. Pearson correlation test was used when the relations between the parameters were examined. Chi-square test was used for comparison of qualitative data. The results were evaluated in a confidence interval of 95% and a significance level of p <0.05.

Results

This study included 130 patients consisted of 67 newly diagnosed T2DM (group D) and 63 newly diagnosed prediabetic (group PD) patients. There was no statistically significant difference in mean age between the group D (44.89±7.67 years) and group PD (42.14±8.74 years) (p=0.058) patients. Only 7.7% (n = 10) of our study population was over 55 years of age.

Descriptive data of groups D and PD is shown in Table 1. In group D, the mean Mg level (1.88±0.17 mg/dL) was significantly lower than group PD (1.96±0.17 mg/dL) (p=0.007). Also, in group D, serum glucose, HOMA-IR and HbA1c levels were found to be statistically higher than group PD whereas BMI and magnesium levels in the group PD were found to be statistically higher than group D (Table 1).

Table 1. Descriptive data of diabetic and prediabetic patients and comparison between the groups.

	Group PD (n=63)¥	Group D (n=67)¥	p
Age (year)	42.14±8.74	44.89±7.67	0.058
BMI (kg/m²)	34.41±6.46	28.77±5.21	0.0001
Glucose (mg/dl)	96.22±10.01	191.16±81.67	0.0001
Insulin (μu/ml)	14.95±6.50	15.60±16.64	0.205
HOMA-IR score	3.57±1.61	7.22±9.22	0.001
HbA1c (%)	5.70±0.40	8.40±2.46	0.0001
Ca (mg/dl)	9.62±0.46	9.43±0.42	0.012
Mg (mg/dl)	1.96±0.17	1.88±0.17	0.007
Vitamin D (ng/ml)	16.11±11.36	19.57±10.77	0.088

¥: Mean±standard deviation, BMI: Body mass index, HOMA-IR: Homeostatic Model Assessment - Insulin Resistance, Ca: Calcium, Mg: Magnesium, HbA1c: Glycosylated hemoglobin

Significant negative correlations were found between Mg and glucose levels (r=-0.390; p=0.001) and HOMA-IR values (r =-0.284; p=0.022) in group D, but the same correlations were not found in group PD. Also, age, BMI and serum insulin levels were not correlated with serum Mg levels in both groups (Table 2).

Table 2. Correlation analysis between Mg level and BMI, blood glucose, insulin, and HbA1c levels.

Magnesium	Prediabetes		Diabetes	
	r	p	r	p
Age (year)	0.065	0.611	0.083	0.506
BMI (kg/m²)	-0.051	0.691	-0.031	0.809
Glucose (mg/dl)	0.01	0.939	-0.390	0.001
Insulin (μu/ml)	-0.032	0.801	-0.108	0.393
HOMA-IR score	0.000	0.998	-0.284	0.022
HbA1c (%)	0.217	0.087	-0.240	0.051

BMI: Body mass index, HOMA-IR; Homeostatic Model Assessment - Insulin Resistance, HbA1c: Glycosylated hemoglobin

Discussion

This study shows the effect of serum magnesium levels on serum glucose and HOMA-IR values in T2DM patients which could have an impact on diabetes regulation in those patients in clinical routine.

Electrolyte disorders are common in diabetic patients and closely related to increased morbidity and mortality. In a study, a total of 5179 patients over 55 years old have been evaluated for electrolyte disturbance and at least one electrolyte imbalance has been observed in 776 cases (15%) [14]. Electrolyte imbalance is more commonly seen in patients with poor blood glucose regulation and those with renal dysfunction [8, 15]. In our study, patients with renal dysfunction were excluded from the study in order to exclude any conflict.

One of the common electrolyte disorders among diabetic patients is hypomagnesaemia. In a study published in 2004 in United States [16], in which participants who were consisted of 40,000 women aged 45 years and older, 918 subjects had diabetes mellitus and lower magnesium levels than non-diabetic subjects. Similar results have also been obtained in another study [14] aiming to determine the frequency of electrolytic impairment in the elderly population in 2013. Analysis of that study has shown that diabetes was an independent risk factor for hypomagnesaemia in people aged 55 years or older. A study by Odusan et al. [17] has shown that diabetic patients had a lower magnesium level than non-diabetics. In that study, about one-quarter of diabetic patients had hypomagnesemia. In our study, we have determined a significant negative correlation between serum magnesium and glucose level in diabetic patients but there was no correlation in prediabetic patients. However, we could not find a significant relationship between Mg level and age in our study. Similar result was found in the study by Arpaci et al. [18]. This could be caused from the younger age of the patient population taken into the our study.

Studies conducted by Dasgupta et al. [19] and Guerro-Romero et al. [20] have shown that hypomagnesemia increases the risk of complications in diabetic patients, affects glucose regulation badly. A study published in 2018 [21] has been suggested that magnesium might be important because of the antioxidant effect in providing metabolic control of type 2 diabetes. Reasons for the frequent occurrence of hypomagnesemia in diabetics include inappropriate magnesiumuria, incomplete magnesium intake, glomerular hyperfiltration, impaired insulin metabolism, diuretic usage, and recurrent metabolic acidosis [22, 23]. In our study, we have excluded the patients who were using any anti-hypertensive drugs and also patients with renal dysfunction. However, we did not determine the urinary Mg levels in our patients. And we also did not calculate the levels of eGFR (glomerular filtration rate) in our patients. In terms of metabolic acidosis, having a history of diabetes including diabetic ketoacidosis was also an exclusion criterion of our study. We found a significant negative correlation between Mg level and HOMA-IR values in diabetic patients but no correlation was found in prediabetic patients.

The detection and correction of altered Mg status in diabetic patients is clinically appropriate, although many physicians tend to ignore Mg status. The increased risk of developing impaired glucose tolerance and/or frank DM2 in persons with dietary or serum Mg deficits have suggested a potential benefit of Mg supplements in patients with DM2 or in the presence of risk factors for DM2. Mg supplements have been proposed as a complementary tool for the prevention of DM2 and its metabolic control [1].

T2DM is a condition in which the electrolyte disorders are frequently seen due to the pathophysiology of the disease as well as the drugs used and comorbid conditions. It is important to evaluate the electrolytes and to take measures to correct this condition if any disorder is detected [24]. Some benefits of Mg supplements on glycemic profiles have been found in most but not all studies. In our study, we showed a significant negative correlation between magnesium levels and HOMA-IR and fasting blood glucose levels in diabetic patients, but this correlation did not exist in prediabetic ones. Our study included newly diagnosed patients in order to avoid a possible interference between our results and 'disease other than diabetes-related' or drug-related Mg disturbance. As we did not investigate the effect of magnesium on diabetes regulation, we could not evaluate the clinical efficacy of magnesium replacement on T2DM patients.

In conclusion, our study results suggest that serum Mg level is associated with metabolic control of T2DM, and thus it can be considered in T2DM patients.

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