

Serum magnesium levels in patients with the necrotizing and edematous types of acute pancreatitis with and without hypocalcemia

Hipokalseminin eřlik ettiđi ve etmediđi nekrotizan ve ödematöz tip akut pankreatitli olgularda serum magnezyum düzeyleri

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ABSTRACT

Objective: We aimed to investigate the association of serum magnesium levels with the disease state in patients having necrotizing and edematous types of acute pancreatitis with or without hypocalcemia.

Methods: The hospital records of 114 patients, meeting the criteria of the revised Atlanta classification of acute pancreatitis were evaluated retrospectively for their serum magnesium, calcium, albumin and C-reactive protein (CRP) levels and leukocyte and platelet counts.

Results: Mean age of the patients was 58.9±15 years. Serum magnesium, calcium and albumin levels were significantly lower in patients with acute necrotizing pancreatitis than those of the cases with the edematous type (1.85±0.6 mg/dL vs. 2.12±0.26 mg/dL; p<0.001, 8.37±0.51 mg/dL vs. 8.86±0.59 mg/dL; p<0.001 and 3.34 g/dL±0.67 g/dL vs. 3.75±0.46 g/dL; p=0.003, respectively). Patients with hypocalcemia had lower levels of serum magnesium, and higher levels of serum CRP and leucocyte counts when compared with the patients without hypocalcemia (p<0.001, p=0.002 and p=0.002, respectively). According to the type of disease, the number of patients with advanced age increased 1.047-fold (CI: 1.006-1.089; p=0.025), normal levels of serum magnesium increased 45.4-fold (CI: 3.548-582.336; p=0.003) in patients with the edematous type, and, high levels of serum CRP increased 1.082-fold (CI: 1.017-1.157; p=0.013) in patients with the acute necrotizing pancreatitis. After the disease severity was taken under control, serum magnesium levels were found to be moderately correlated with the serum albumin levels (r=0.32; p<0.001).

Conclusion: Although patients with acute necrotizing pancreatitis and hypocalcemia revealed low levels of serum magnesium, hypomagnesemia was not associated with the disease severity in patients with acute pancreatitis.

Key words: Acute pancreatitis, Atlanta classification, magnesium, calcium

ÖZ

AmaĀ: Nekrotizan ve ödematöz tip akut pankreatitli, hipokalsemisi olan ve olmayan hastaların serum magnezyum düzeylerinin hastalık ile iliřkisini incelemeyi amaçladık.

Yöntem: Akut pankreatit için revize edilmiř Atlanta kriterlerini karřılayan 114 hastanın hastane kayıtlarından geriye dönük olarak serum magnezyum, kalsiyum, albumin, C-reaktif protein düzeyleri ile lökosit ve trombosit sayıları deđerlendirildi.

Bulgular: Yař ortalaması 58,9±15 yıldır. Serum magnezyum, kalsiyum ve albumin düzeyleri nekrotizan tip akut pankreatitli hastalarımızda ödematöz tipteki akut pankreatitli hastalarımıza göre anlamlı derecede düşüktü. Sırasıyla (1,85±0,6 mg/dL vb. 2,12±0,26 mg/dL; p<0,001, 8,37±0,51 mg/dL vb. 8,86±0,59 mg/dL; p<0,001 ve 3,34 g/dL±0,67 g/dL vb. 3,75±0,46 g/dL; p=0,003). Tüm hasta grubunda hipokalsemi saptananlarda saptanmayanlara göre serum magnezyum düzeyleri düşük, serum CRP düzeyleri ve lökosit sayıları yüksek bulundu. Sırasıyla (p<0,001; p=0,002 ve p=0,002). Hastalık tipine göre yapılan deđerlendirmede, ödematöz tip akut pankreatitli hastalarda ileri yařın 1,047-kat (CI: 1,006-1,089; p=0,025), normal düzeylerdeki serum magnezyumun 45,4-kat (CI: 3,548-582,336; p=0,003), nekrotizan tip akut pankreatitli hastalarda yüksek serum CRP düzeylerinin 1,082-kat (CI: 1,017-1,157; p=0,013) daha fazla görüldüđü saptandı. Hastalık řiddeti kontrol altına alındıktan sonra serum magnezyum ile albumin düzeylerinin orta düzeyde (r=0,32; p<0,001) iliřkili olduđu saptandı.

Sonuç: Nekrotizan tip akut pankreatitli ve hipokalsemisi olan hastalarımızda serum magnezyum düzeyleri düşük bulunsada akut pankreatitte hipomagnezeminin hastalık řiddeti ile iliřkisi bulunamadı.

Anahtar kelimeler: Akut pankreatit, Atlanta sınıflaması, magnezyum, kalsiyum

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INTRODUCTION

Hypomagnesemia is a common entity occurring in up to 12% of inpatients ⁽¹⁾. Two major mechanisms namely gastrointestinal and renal losses can induce hypomagnesemia. Hypomagnesemia is often associated with hypokalemia and hypocalcemia. Hypocalcemia has been reported to occur in 10 to 80% of the patients with acute pancreatitis which is considered to be a poor prognostic sign ^(2,3). The mechanism of hypomagnesemia is presumably similar to the mechanism partially responsible for hypocalcemia in acute pancreatitis, ie. saponification of magnesium and calcium in necrotic fat ^(2,3). The purpose of this study was to evaluate the effects of the necrotizing and edematous types of acute pancreatitis on serum magnesium levels in addition to other factors associated with disease severity in patients with and without hypocalcemia.

MATERIAL and METHODS

PATIENTS

Sixty-five female and 49 male patients meeting the criteria of the revised Atlanta classification of acute pancreatitis ⁽⁴⁾ were evaluated for their serum magnesium, calcium, albumin and C-reactive protein (CRP) levels, leukocyte and platelet counts. This study included inpatients between 19 and 86 years of age. Data were collected from the files of the patients admitted to our clinic between June 2009 and December 2012.

Acute pancreatitis was classified according to the international consensus known as the revised Atlanta classification ⁽⁴⁾. Necrotizing pancreatitis was defined as necrosis involving both the pancreas and peripancreatic tissues, necrosis of only the peripancreatic tissues or only the pancreatic parenchyma. Interstitial edematous pancreatitis was defined as the diffuse or localized enlargement of the pancreas due to inflammatory edema. Persistent and single or multiple organ failure denoted the severe

type and absence of organ failure and local or systemic complications denoted the mild type of acute pancreatitis. Moderately severe pancreatitis was defined by transient organ failure or local or systemic complications in the absence of persistent organ failure ⁽⁴⁾.

The patients were divided into two groups as follows: Group 1 included 84 patients with the interstitial acute edematous pancreatitis without organ failure, local or systemic complications, and Group 2 included 30 patients with the acute necrotizing pancreatitis without features of the persistent single or multiple organ failure, but with transient local or systemic complications.

According to disease etiology, 87 patients had biliary tract disease induced by gallstones, 27 patients had nonbiliary tract disease with different etiologies including hypertriglyceridemia (n=10), idiopathic (n=7), drug-related causes (n=2, corticosteroid therapy; n=1, potent loop diuretics and n=1, estrogen therapy), post-ERCP complications (n=3), pregnancy with hypertriglyceridemia (n=2) and pregnancy alone (n=1).

The medical files revealed that the patients with acute pancreatitis were diagnosed according to their clinical signs and symptoms in addition to laboratory test results, and abdominal ultrasonographic findings obtained upon admission.

Written informed consent was obtained from all patients for future publication, and the study protocol was approved by the hospital's ethics committee. The study was conducted in accordance with the criteria of Good Clinical Practice and principles of Declaration of Helsinki.

Definition of acute pancreatitis

Acute pancreatitis was defined as the presence of two of the following three features ⁽⁴⁾: 1) abdominal pain consistent with acute pancreatitis (acute onset of persistent, severe, epigastric pain often radiating to the back); 2) serum lipase activity (or amylase activity) at least three times greater than the upper limit of normal (ULN); and 3) characteristic findings of

acute pancreatitis on contrast-enhanced computed tomography (CECT) or transabdominal ultrasonography. If the abdominal pain and increase in serum pancreatic enzyme activities established the diagnosis of acute pancreatitis, then CECT was not required upon admission to the hospital.

The study population achieved the first two diagnostic criteria of acute pancreatitis, and all of them had transabdominal ultrasonography findings consistent with the characteristic morphological features of acute pancreatitis upon admission. Twenty-nine patients (96%) with necrotizing type and 77 patients (91.6%) with acute edematous pancreatitis underwent abdominal tomographic examinations after admission. Other patients (one necrotizing type and seven edematous type) were evaluated by endosonographic ultrasound.

Exclusion criteria

The recorded files of the patients who were diagnosed with acute pancreatitis during the study period were evaluated, and those with liver disease, renal failure, malignancy, acute infection, systemic or metabolic disorders such as diabetes mellitus and hypokalemia, current alcohol consumers and patients on potassium, calcium or magnesium therapy were not included in this study.

Evaluation of serum magnesium levels

Normal range of serum magnesium levels indicated on the label of the commercial kit (reference no.: 3P68-31, lot no.: 42279UN13, Abbott Laboratories, Wiesbaden, Germany) was between 1.8 and 2.5 mg/dL. Upon admission, 10 patients (33.4%) with the necrotizing type and seven patients (8.4%) with the acute edematous pancreatitis had serum magnesium levels lower than 1.8 mg/dL. Among these patients with hypomagnesemia, serum magnesium levels ranged from 1.27 to 1.77 mg/dL in the group of patients with the acute necrotizing pancreatitis and from 1.42 to 1.78 mg/dL in the group of patients with the edematous type.

Evaluation of serum calcium levels

Normal range of serum calcium levels indicated on the label of the commercial kit (reference no.: 3L79-31, lot no.: 45166UN14, Abbott Laboratories, Wiesbaden, Germany) was between 8.5 and 10.5 mg/dL. A total of 81 patients had serum calcium levels between 8.5 and 10.7 mg/dL, and 33 had serum calcium levels of <8.5 mg/dL, with a minimum level of 6.90 mg/dL.

Evaluation of clinical outcomes

According to the data in the files, all patients with the acute edematous pancreatitis survived and did not show any clinical manifestations of hypomagnesemia, systemic complications or single or multiple organ failure related to acute pancreatitis. Four patients who died in the Group 2 (the acute necrotizing pancreatitis) had serum magnesium levels of 2.08 mg/dL, 1.87 mg/dL, 1.74 mg/dL and 1.64 mg/dL. The patients with serum magnesium levels of 2.08 mg/dL and 1.74 mg/dL died of respiratory failure caused by nosocomial pneumonia on their 16th and 25th days in the hospital. The patient with the serum magnesium level of 1.87 mg/dL died of cardiac failure on the 21st day of her hospital stay and the patient with the serum magnesium level of 1.64 mg/dL died of severe septicemia on the 22nd day of his hospital stay.

The hospital files did not indicate any major clinical manifestations of hypomagnesemia (5) including neuromuscular, cardiovascular and metabolic disorders in these patients.

Laboratory measurements

High-sensitivity C-reactive protein (hs-CRP) levels were immunologically determined by an immunoturbidimetric method using a Multicent CRP Vario Kit (reference no.: 6K26-41, lot no.: 41270Y600, Abbott reagents, Wiesbaden, Germany). The normal range for the kit used to measure high-sensitivity CRP varied from 0.01 mg/dL to 16 mg/dL. Serum albumin, calcium, and magnesium levels were determined by a colorimetric turbidimetric method using

an Abbott Architect C-16000 Autoanalyser (Abbott reagents, Germany). For the detection of calcium, and magnesium (Arsenazo III), and albumin (bromocresol green) the indicated reactants were used. Leukocytes and platelets were counted using a standardized hemocounter.

Statistical analysis

For descriptive purposes, baseline characteristics, including sex and the type and etiology of acute pancreatitis were presented as numbers (%), age, serum albumin, calcium and magnesium levels as means (\pm SD), and high-sensitivity CRP and leukocyte and platelet counts as medians (IQR) because they were not distributed normally, showing right skewness in statistical analysis. The independent-samples t test was used to determine differences in age, serum albumin, calcium and magnesium levels, and the Mann-Whitney U test to determine differences in high-sensitivity CRP levels and leucocyte and platelet counts between the patients with necrotizing and interstitial edematous acute pancreatitis. The differences between the categorical variables, including sex, underlying disease etiology and the presence or absence of hypocalcemia, were evaluated using Pearson's chi-square test.

For the patients with and without hypocalcemia, the independent-samples t test was used for the comparison of serum albumin levels and the Mann-Whitney U test for the comparisons of leukocyte and platelet counts and serum calcium, magnesium and CRP levels.

Logistic regression analysis was performed to assess the associations between the type of acute pancreatitis and age, leukocyte and platelet counts and serum calcium, magnesium, albumin and high-sensitivity CRP levels. Age and the serum magnesium and high-sensitivity CRP levels revealed statistically significant correlations with acute pancreatitis. The results were expressed as odds ratios (ORs) with 95% Confidence Intervals (CIs).

Finally, partial correlation analysis was performed between age, leukocytes, platelets, albumin, calcium,

magnesium and high-sensitivity CRP after adjustments were made for the disease type and severity. The results were expressed as the correlation coefficient "r" for any correlation that existed. A *p* value of <0.05 was considered to be statistically significant.

All calculations were carried out using SPSS version 15.0 for Windows (Candan H www.tibbiistatistikci.com&www.medicalstatistic.com, Izmir, Turkey).

RESULTS

This study included a total of 114 (female, n=65: %57, and male, n=49: 43%) inpatients. The mean age of the patients was 58.9 \pm 15 years. Eighty-four patients (73.7%) had interstitial edematous type and 30 patients (26.3%) acute necrotizing pancreatitis. In terms of disease etiology, patients had had biliary tract disease (n=87 ;76.3%), and acute pancreatitis of another etiology (n=27; 23.7%). Table 1 shows the ages and descriptive findings of the patients. The distributions of sex and disease etiology did not differ between the patients in the groups of edematous and necrotizing types of acute pancreatitis (male: 44% vs. 40% and female: 56% vs. 60%; *p*=0.701 and biliary tract disease: 75% vs. 80% and nonbiliary tract disease: 25% vs. 20%; *p*=0.580). For the patients with the acute edematous pancreatitis, the female patients were older than the male counterparts (65.3 \pm 15.5 vs.

Table 1. Age and the descriptive values of the 114 patients with the interstitial edematous and necrotizing types of acute pancreatitis.

	mean \pm SD (min-max)	Median
Age, years	58.98 \pm 15.60 (19.00-86.00)	58.50
Leukocytes, K/uL	13597.19 \pm 6226.22 (4670.00-34800.00)	12200.00
Platelets, K/uL	284552.63 \pm 105091.46 (131000.00-932000.00)	272000.00
Albumin, g/dl	3.64 \pm 0.55 (2.00-4.80)	3.70
Calcium, mg/dl	8.73 \pm 0.61 (6.90-10.70)	8.75
Magnesium, mg/dl	2.05 \pm 0.28 (1.27-2.61)	2.04
CRP, mg/dl	9.88 \pm 9.57 (0.28-34.90)	6.35

Min: minimum level, Max: maximum level, CRP: C-reactive protein.

53.2±15.7 years; p=0.001). For the patients with the acute necrotizing pancreatitis, the age did not differ significantly between the female and male patients (54.1±13.6 vs. 59.0±7.9 years; p=0.273). Serum levels of albumin, calcium and magnesium were lower in the patients with acute necrotizing pancreatitis than in those with the edematous type (3.34±0.67 g/dL vs. 3.75±0.46 g/dL; p=0.003, 8.37±0.51 mg/dL vs. 8.86±0.59 mg/dL; p<0.001, and 1.85±0.6 mg/dL vs. 2.12±0.26 mg/dL; p<0.001, respectively). Leukocytes, platelets and levels of high-sensitivity CRP were not normally distributed, so these data were expressed as medians (IQRs). The leukocyte counts and levels of high-sensitivity CRP were significantly higher in the acute necrotizing pancreatitis patients than in those with the edematous type (14.3 K/uL (7.2 K/uL) vs. 11.6 K/uL (5.9 K/uL); p=0.041; and 17.34 mg/dL (24.24 mg/dL) vs. 4.75 mg/dL (8.41 mg/dL); p<0.001, respectively). In the patients with acute necrotizing pancreatitis, hypocalcemia was more frequent than in those with the edematous type. Hypocalcemia was detected in 17 (20.2%) out of 84 patients with the edematous type and in 16 (53.3%)

Table 2. Comparisons of serum albumin, calcium, magnesium and CRP concentrations, leukocyte and platelet counts in patients with the necrotizing and interstitial edematous types of acute pancreatitis with and without hypocalcemia.

		Hypocalcemia		P
		Absent (n=81)	Present (n=33)	
Leukocytes, K/uL	Median	11400.00	14800.00	0.002
	IQR	5950.00	8500.00	
Platelets, K/uL	Median	270000.00	278000.00	0.759
	IQR	128000.00	59000.00	
Albumin, g/dl	Mean	3.70	3.51	0.088
	SD	0.56	0.52	
Calcium, mg/dl	Median	9.00	8.20	<0.001
	IQR	0.50	0.50	
Magnesium, mg/dl	Median	2.07	1.91	0.001
	IQR	0.31	0.44	
CRP, mg/dl	Median	5.01	17.56	0.002
	IQR	7.75	19.77	

Independent T Test :- Mann Whitney U Test

IQR; interquartile range, CRP; C-reactive protein

Except for the serum albumin concentration, the leukocyte and platelet counts, serum calcium, magnesium and CRP concentrations are not normally distributed and the data are expressed as median and range (IQR). Serum albumin concentration is expressed as mean±SD.

out of 30 patients with the necrotizing type acute pancreatitis; (p<0.001).

The leukocyte and platelet counts and serum albumin, magnesium and CRP levels were compared between the patients with and without hypocalcemia as shown in Table 2. The patients with hypocalcemia had higher leukocyte counts and serum high-sensitivity CRP (p=0.002 and p=0.002), and lower serum magnesium levels; (p=0.001) than those without hypocalcemia. There was no statistical significant difference between two groups as for serum albumin levels; (p=0.088).

Logistic regression analysis was performed to assess the associations between the type of acute pancreatitis and age, the leukocyte and platelet counts and the serum calcium, magnesium, albumin and high-sensitivity CRP levels. In the final model, age, serum magnesium and high-sensitivity CRP levels were statistically significantly associated with acute pancreatitis. Mean age of the patients increased by 1.047-fold (CI: 1.006-1.089; p=0.025), and levels of serum magnesium increased by 45.4-fold (CI: 3.548-582.336; p=0.003) in the patients with the acute ede-

Table 3. Correlation analysis of the data in the patients with acute pancreatitis after an adjustment was made for the disease severity, n=114.

		Leukocytes	Platelets	Albumin	Calcium	Magnesium	CRP
Age	r	0.167	-0.233	-0.245	0.023	-0.187	0.114
	P	0.078	*0.013	*0.009	0.806	*0.048	0.231
Leucocytes	r		0.206	-0.176	-0.195	-0.048	0.313
	P		*0.029	0.062	*0.038	0.617	*0.001
Platelets	r			-0.076	-0.005	0.045	0.158
	P			0.424	0.961	0.637	0.094
Albumin	r				-0.005	0.323	-0.192
	P				0.955	*0.000	0.041
Calcium	r					0.066	-0.330
	P					0.490	*0.000
Magnesium	r						-0.051
	P						0.589

CRP; C-reactive protein

Direct, moderately powerful and significant correlations between serum magnesium and albumin levels; p<0.001^a, between serum CRP level and leukocyte counts; p=0.001^b and an inverse, moderately powerful and significant correlation between serum CRP and calcium levels; p<0.001^c were determined. Inverse, weakly powerful but significant correlations between age and serum albumin level; p=0.009^d, between age and serum magnesium level; p=0.048^e, between leukocyte counts and serum calcium level; p=0.038^f and direct, weakly powerful but significant correlations between age and platelet counts; p=0.013^g, and, between leukocyte and platelet counts; p=0.029^h also existed.

matous pancreatitis. Levels of high-sensitivity CRP increased by 1.082 fold (CI: 1.017-1.157; $p=0.013$) in the patients with acute necrotizing pancreatitis.

After an adjustment was made for the disease type and severity, partial correlation analysis revealed direct and moderately powerful correlations between the serum magnesium and albumin levels ($r=0.32$; $p<0.001$) and between the serum high-sensitivity CRP level and the leukocyte count ($r=0.31$; $p=0.001$). An inverse and moderately powerful correlation was determined between serum high-sensitivity CRP and calcium levels ($r= -0.33$; $p<0.001$). A weak and an inverse correlation between age and serum magnesium level ($r= -0.18$; $p=0.048$) also existed. All of these correlations are indicated in Table 3.

DISCUSSION

The revised Atlanta classification ⁽⁴⁾ was used to define acute pancreatitis in our patients. In general, the severity of acute pancreatitis is considered to be predictive of the prognosis of the disease according to some specific criteria, such as Ranson's, Glasgow's, the APACHE system and Balthazar's, which differentiate the mild and moderate forms from the severe form ^(4,6,7), which were beyond the scope of this study. Our aim was to evaluate the association of necrotizing and edematous types of acute pancreatitis using serum magnesium levels in patients with and without hypocalcemia.

In the plasma, the concentration of magnesium is relatively constant within narrow limits and in the serum, nearly three-fourths of it is ultrafiltrable. In acute pancreatitis, hypomagnesemia and hypocalcemia may occur alone or in combination, presumably due in part to the deposition of these cations in areas of fat necrosis ⁽⁸⁾. Magnesium is primarily an intracellular cation; thus serum magnesium concentrations may not adequately reflect tissue magnesium stores. Although a few studies have reported hypomagnesemia in some patients with acute pancreatitis, serum magnesium concentrations are usually normal ⁽²⁾, and only some of the patients with acute pancreatitis

revealed the symptoms and metabolic aberrations of hypomagnesemia ⁽⁸⁾. In our study, among 114 patients with interstitial edematous and necrotizing types of acute pancreatitis, 17 had hypomagnesemia and 33 hypocalcemia during an acute episode of pancreatitis upon admission to the hospital. Our findings revealed that hypomagnesemia did not appear to be related to the drop in serum calcium levels, and thus, we did not find a correlation between the serum calcium and magnesium levels. The only statistically significant correlation was revealed between the serum magnesium and albumin levels. Hersh et al. ⁽⁸⁾ have revealed similar results. Ryzen et al. ⁽²⁾ have reported that 21% of their patients with acute pancreatitis had hypomagnesemia and their results were in accordance with those reported by Haldimann et al. who detected overt hypomagnesemia in approximately 25% of the patients with pancreatitis and found that hypocalcemia is more common in patients with hypomagnesemia along with a significant correlation between serum calcium and magnesium levels. However, Ryzen et al. ⁽²⁾ have not detected a correlation between serum calcium and magnesium levels but have found a significant correlation between serum calcium and intracellular magnesium levels .

Alcoholism is a frequent inciting factor in the pathogenesis of acute pancreatitis. Hypomagnesemia occurs at various stages of alcoholic syndromes, and the decrease in body magnesium may occur irrespective of the presence of liver disease ⁽⁸⁾. Magnesium deficiency in a patient with chronic alcoholism may be more pronounced when the patient develops an attack of pancreatitis ^(2,8,9). Although we observed many patients for whom alcohol had contributed to the etiology of their acute pancreatitis, they were not included in this study to prevent the confounding effect of serum magnesium levels.

Advanced age (>65 years), higher leukocyte counts ($>13000/\text{mm}^3$), and CRP (>150 mg/dL), and lower serum albumin (<2.5 mg/dL), and calcium (<8.5 mg/dL) levels were determined to be the independent but poor prognostic factors associated with acute pancreatitis ⁽¹⁰⁾. There were weak and inverse

correlations between age and serum magnesium levels and also between age and serum albumin levels in our study. The association between advanced age and the type of acute pancreatitis increased by 1.047-fold in the patients with edematous pancreatitis compared to those with necrotizing pancreatitis. Among the main factors that determine the inflammatory response, acute-phase protein of high-sensitivity CRP has the best practical value and it is widely used as a predictor of severe acute pancreatitis (6,7) in the studies. Currently, the cut-off value of 150 mg/dL for hs-CRP discriminates the severe form from the mild form of acute pancreatitis (6). In our patients with the acute necrotizing pancreatitis, serum high-sensitivity CRP level was directly correlated with the leukocyte count and inversely correlated with the serum calcium level. Serum high-sensitivity CRP level increased by 1.082-fold in our patients with the acute necrotizing pancreatitis compared to those with the edematous type. Serum albumin, a negative acute-phase protein, was the only prognostic factor that revealed the presence of a direct and moderately powerful correlation with the serum magnesium level in the study.

Serum magnesium level has not been reported to be a prognostic factor associated with acute pancreatitis in the literature, and our findings revealed that in patients with acute edematous pancreatitis normal levels of serum magnesium was detected 45.4 times more frequently compared with those with the necrotizing type. The clinical features of magnesium deficiency include neuromuscular hyperexcitability, such as paresthesia, muscle cramps, carpopedal spasms, tetany, and convulsions (5,8). If hypocalcemia is a reflection of magnesium deficiency, it is possible that other clinical manifestations of magnesium deficiency, such as cardiac arrhythmia, respiratory muscle weakness, and refractory hypokalemia may contribute to patient morbidity (2,5). In this study, the patients with the interstitial edematous and necrotizing types of acute pancreatitis with low levels of serum calcium and magnesium did not show any clinical manifestations of hypocalcemia or hypomagnesemia, eit-

her alone or in combination. These findings support the results of previous reports in the literature suggesting that the serum magnesium level may be poorly correlated with the manifestations of the deficiency of this cation because its serum levels are maintained at the expense of its intracellular stores (8). In acute pancreatitis complicated by hypomagnesemia and hypocalcemia, administration of parenteral magnesium is vital in the treatment of symptoms resulting from the deficiency of these cations (8).

In conclusion, although the patients with acute necrotizing pancreatitis and with hypocalcemia had low levels of serum magnesium, hypomagnesemia was not associated with either hypocalcemia or the disease severity.

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