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Correlation of Serum Magnesium and Serum Lipid Levels in Hemodialysis Patients

Dear Sir,

Abnormalities in lipid and/or protein content of lipoprotein have been described in patients with chronic renal failure [1, 2]. Hypertriglyceridemia occurs in 50–75% of patients with chronic renal insufficiency. Although hypercholesterolemia is rare in uremic and dialyzed patients, decreased high-density-lipoprotein (HDL) cholesterol (HDL-C) concentration has been documented [3]. Magnesium retention is also a problem in patients on maintenance hemodialysis: the majority of dialysis patients present with hypermagnesemia [4]. Magnesium deficiency has a possible role in the perturbation of lipid metabolism in the non uremic population [5, 6]. Furthermore, it has been shown that in uremic rats magnesium deficiency worsens several serum lipid parameters [7]. We have studied the relation of serum magnesium and plasma lipid levels in uremic hemodialysis patients.

Twenty-five patients (16 men and 9 women, aged 52.76 ± 18.46 years) undergoing conventional hemodialysis thrice weekly were studied. None of the patients had diabetes mellitus. Patients were divided into three groups: Group A (8 patients, mean age 48.9 ± 23.6 years) had plasma cholesterol levels lower than 200 mg/dl; Group B (8 patients, mean age 55.6 ± 15.5 years) had cholesterol levels from 201 to 250 mg/dl; Group C (9 patients, mean age 53.7 ± 17.4 years) had cholesterol levels above 251 mg/dl. The age differences between the groups were not significant. The biochemical characteristics of the three groups are shown in table 1. The time-averaged concentration of urea whole-body urea clearance, and protein catabolic rate are also listed in table 1.

All patients had venous blood taken after a 12-hour fast. The serum was separated and stored at 4°C for analysis of total cholesterol, triglycerides, total HDL-C and HDL triglycerides (HDL-TG), HDL-C fractions (HDL₂-C, HDL₃-C), low-density-lipoprotein (LDL) cholesterol (LDL-C) and triglycerides (LDL-TG), very-LDL (VLDL) cholesterol (VLDL-C) and triglycerides (VLDL-TG), apolipoprotein A (Apo A) and apolipoprotein B₁₀₀ (Apo B). All results are expressed as means with 1 standard deviation. Lipid values were compared by the unpaired Student t test. The relationship between magnesium and lipids was studied using univariate regression analysis.

Serum lipid levels in the three groups are compared in table 2. No differences were found between the three groups for HDL-C, HDL₂-C and HDL₃-C. The A and B groups had similar VLDL-C levels, which were lower than those of group C ($p < 0.01$). LDL-C was lower in group B than in C ($p < 0.001$), and was lowest in A ($p < 0.001$). There was a progressive increase of triglyceride levels from the A to the C group but it was not significant. The three groups had similar Apo-A levels. Apo-B levels were highest in C, lower in B ($p < 0.001$) and lowest in A ($p < 0.001$). A significant increase in LDL-TG was found ($p < 0.05$). No differences were found in calcium, phosphorus and parathyroid hormone. Magnesium was higher in group B than in A, but this difference was not significant. Group C had the highest magnesium levels ($p < 0.05$ relative to groups A and B).

The linear correlation of total cholesterol versus magnesium was significant ($r = 0.55$, $p < 0.001$). The linear regression was statistically significant for magnesium versus LDL-

C ($r = 0.52$, $p < 0.01$). A significant correlation was found between VLDL-C and magnesium ($r = 0.49$, $p < 0.01$), as well as a positive correlation between Apo B and magnesium ($r = 0.52$, $p < 0.01$).

It has been suggested that magnesium deficiency is related to alterations in lipid metabolism. In monkeys, magnesium deprivation associated with an atherogenic diet leads to high blood cholesterol levels [8]. Magnesium-deficient rats maintained on a high-carbohydrate diet had high blood triglyceride levels [6]; thus in magnesium-deficient non-uremic rats no changes in serum total cholesterol were found. Recently Inagaki et al. [7] found that in uremic rats magnesium deficiency increased serum triglyceride levels and decreased HDL-C levels.

Surprisingly, in the present results, a positive significant correlation between magnesium levels and total cholesterol, LDL-C, VLDL-C and apo-B levels was found in hemodialyzed uremic patients. There was also a nearly significant correlation of triglycerides and magnesium levels. At first sight our data seem to contradict accumulated experience, but there are conflicting data on cholesterol in man and the experimental rat. Whereas in uremic patients HDL-C is commonly reduced, in contrast, in uremic rats elevated total cholesterol and HDL-C levels have been observed [7]. Moreover, while most cholesterol appears to be transported in HDL in rats; in man, LDL appears to be the principal class involved in the transport of plasma cholesterol [9]. Experimentally, magnesium seems not to increase lipoprotein synthesis but to be involved in the regulation of cholesterol ester hydrolases, which promote the mobilization of these esters [10,

Table 1. Biochemical status of uremic patients

	Group A	Group B	Group C
Glucose	104.8±30.5	110.4±47.5	94.5±14.6
Urea	185.5±39.2	189.3±29.0	181.2±30.2
Creatinine	10.0±3.7	11.5±2.5	12.4±1.6
Uric acid	7.6±1.2	7.7±1.4	6.8±1.4
Albumin	4.8±0.8	4.8±0.9	4.3±0.9
Total protein	6.9±0.8	6.9±0.3	7.0±0.4
TAC	62.1±13.1	58.8±11.1	58.1±8.1
Kt/V	1.02±0.11	0.96±0.13	1.05±0.14
PCR	1.00±0.23	0.97±0.15	1.05±0.15
Calcium, mg/dl	9.0±1.2	9.3±0.9	9.2±0.8
Phosphorus, mg/dl	5.0±2.3	5.8±1.6	5.9±2.5
Magnesium, mg/dl	2.0±0.3	2.1±0.2	2.4±0.3*
PTH, pg/ml	378.8±465.5	162.5±136.5	223.4±300.8

* $p < 0.05$ compared to groups A and B. TAC = Time-averaged concentration of urea; Kt/V = whole-body urea clearance; PCR = protein catabolic rate; PTH = parathyroid hormone.

Table 2. Lipid and lipoprotein levels of study subjects

	Group A	Group B	Group C
Cholesterol	176.6±19.3	215.8±11.7 ¹	289.9±49.4 ^{1,2}
HDL-C	33.3±12.4	38.1±15.8	40.8±34.3
LDL-C	104.3±26.5	141.8±23.1 ³	196.2±30.6 ^{1,4}
VLDL-C	39.1±15.3	35.9±9.8	61.8±31.7 ⁵
HDL ₂ -C	8.8±4.8	11.4±6.5	7.9±4.2
HDL ₃ -C	24.5±7.9	26.7±10.0	21.8±9.1
Triglycerides	114.1±48.8	177.4±74.6 ⁶	225.4±151.2 ⁶
HDL-TG	12.7±5.1	19.5±9.6	13.3±5.1
LDL-TG	56.7±17.8	75.8±27.4	92.3±37.6
VLDL-TG	47.7±33.0	82.2±49.9	119.8±114.9 ⁷
Apo A	126.6±12.8	131.6±16.5	122.9±13.0
Apo B	108.0±14.5	128.8±12.6 ³	159.5±16.9 ^{1,4}

All values expressed as mg/dl.

¹ $p < 0.001$ compared to group A.

² $p < 0.01$ compared to group B.

³ $p < 0.01$ compared to group A.

⁴ $p < 0.001$ compared to group B.

⁵ $p < 0.05$ compared to group B.

⁶ $p < 0.1$ compared to group A.

⁷ $p < 0.05$ compared to group A.

11]. Therefore, if magnesium can induce an increase in HDL-C in rats, it could be expected to induce an increase in LDL-C in man, as our results showed.

Magnesium seems to have little effect on triglycerides. Uremic magnesium-deficient rats have higher triglyceride levels than uremic non-magnesium-deficient controls [7]. In our data there was a trend of increasing triglyceride levels with increasing magnesium levels. It is known that magnesium may induce changes in hepatic triglyceride metabolism [6].

Hyperparathyroidism is related to disturbances of lipid metabolism [12]. Furthermore, parathormone secretion is influenced by magnesium [13]. In the present results there were no notable differences in calcium, phosphorus or parathyroid hormone levels between the three groups. We can therefore eliminate the influence of parathyroid hormone in our results. Lipid levels seems not to be influenced by 1,25-(OH)₂-D₃ treatment in uremic hemodialysis patients [14].

In conclusion, the results suggest that magnesium might affect lipid metabolism in hemodialysis patients. The increase of serum magnesium levels in hemodialysis patients may worsen dyslipemia. Further clinical studies are required to confirm this hypothesis.

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