

Impact of Serum Magnesium Level on BP, Weight Gain and Intradialytic Symptoms in HD Patients

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Objective: To evaluate the impact of serum magnesium (Mg) level on blood pressure, interdialytic weight gain, and intradialytic cramps and hypotension.

Design: A Cross-Sectional Study.

Setting: King Abdulaziz Medical City, Riyadh, Saudi Arabia.

Method: A cross-sectional study was performed on all patients dialyzing for ≥ 6 months who had no concurrent illnesses. The following data were documented: sex, age, hemodialysis (HD) vintage, pre-dialysis serum levels of calcium (Ca), Mg, intact serum parathyroid hormone (PTH), interdialytic weight gain, pre and post-dialysis systolic blood pressure (SBP) and diastolic blood pressure (DBP), intra-dialytic cramps and symptomatic hypotension.

Correlation between serum Mg and the above parameters were calculated using Pearson correlation test. Independent t-test was used to evaluate the impact of the measured parameters on intradialytic hypotension and cramps.

Result: Two hundred thirty-one patients were included in the study; the mean age was 59.8 ± 16.7 years, 127 (55.0%) were males, the mean HD vintage was 2.5 ± 1.8 years and the mean interdialytic weight gain was 1.8 ± 1.1 kg. Serum calcium, PTH, and Mg levels were 2.2 ± 0.22 mmol/l, 42.9 ± 59.1 pmol/l and 0.94 ± 0.18 mmol/l respectively. Cramps occurred in 31 (13.6%) and symptomatic hypotension in 29 (12.6%). Mg level was significantly positively correlated with pre-dialysis DBP ($P=0.016$) and SBP ($P=0.05$). There was no correlation between Mg level and age, sex, dialysis vintage, cramps, hypotension, Ca or PTH level.

A positive correlation was found between pre-dialysis DBP and weight gain ($P=0.0029$). Age was positively correlated with post SBP ($P=0.007$) and negatively associated with pre-dialysis DBP ($P=0.005$) and weight gain ($P=0.02$).

Conclusion: Mg level was associated with higher BP. Lower PTH level was observed in patients who suffered from cramps. Age was positively correlated with post SBP and negatively associated with pre dialysis DBP and weight gain.

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Serum magnesium plays an important role in many physiological functions in the body including as a cofactor in the phosphorylation of proteins and nucleic acids and its deficiency is linked to vascular disease as well as increased inflammatory response^{1,2}.

PTH increases Mg level by increasing its gastrointestinal absorption, bone resorption, and renal reabsorption. On the other hand, Mg is essential for the synthesis, release, and

adequate tissue sensitivity of PTH. Paradoxically, very low serum Mg concentration causes block of PTH secretion³.

In hemodialysis patients, Mg levels rise and parallel magnesium levels in the dialysate. Changes in Mg level occurring during dialysis has been shown to be significantly correlated with intradialytic hypotension, which might be due to reduced vascular tone associated with hypomagnesemia^{4,5}.

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In addition, plasma ionized Mg is negatively correlated with QT dispersion indicating that Mg plays a role in myocardial electrical stability in hemodialysis patients^{6,7}. Low Mg is associated with higher mortality among hemodialysis patients^{8,9}.

The aim of this study is to evaluate the relationship between serum magnesium (Mg) level with pre and post-dialysis systolic (SBP) and diastolic (DBP) blood pressure, interdialytic weight gain, intradialytic cramps and hypotension, PTH and calcium.

METHOD

Two hundred thirty-one patients dialyzing for at least 3 months at the dialysis center and had no concurrent illnesses were included in the study. The following parameters were documented: sex, age, HD vintage, pre-dialysis serum levels of calcium (Ca), Mg, intact serum PTH, interdialytic with gain, pre- and post-dialysis SBP and DBP.

Using JMP statistical package, descriptive statistics were generated (mean, STD) for continuous variables and frequencies for categorical parameters. Pearson correlation test and Independent t-test were used.

RESULT

Two hundred thirty-one patients were included in the study; the mean age was 59.8±16.7 years, 127 (55%) were males, HD vintage was 2.5±1.8 years, and interdialytic weight gain was 1.8±1 kg. Serum calcium was 2.2±0.22 mmol/l, serum PTH was 42.9±59.1 pmol/l and Mg was 0.94±0.18 mmol/l. Cramps occurred in 31 (13.6%) and symptomatic hypotension in 29 (12.6%), see table 1.

Table 1: Parameters Evaluated

	Mean	Std. Deviation
Duration on dialysis (yrs.)	2.5	1.8
Age (years)	59.8	16.7
Pre-dialysis Systolic BP (mmHg)	136.0	26.9
Pre-dialysis Diastolic BP(mmHg)	66.5	16.6
Post-dialysis Systolic BP(mmHg)	138.5	25.5
Post-dialysis Diastolic BP(mmHg)	67.4	15.9
Weight gain (Kg)	2.8	1.1
Serum Ca (mmol/l)	2.2	0.22
Serum PTH (pmol/l)	42.9	59.1
Serum Mg (mmol/l)	0.94	0.18
Cramps		13.6%
Hypotension		12.6%

A significant positive correlation was found between serum Mg level and pre-dialysis DBP (P=0.016) and pre-dialysis SBP (0.05), see table 2 and figure 1. No correlation was found between Mg level and age, sex and dialysis vintage, cramps or hypotension, Ca or PTH level. A significant positive

correlation was found between pre-dialysis DBP and weight gain (P=0.0029), see table 2 and figure 1.

Age was positively correlated with post SBP (P=0.007) and negatively associated with pre-dialysis DBP (P=0.005) and weight gain (P=0.02), see table 2 and figure 3.

In the group that suffered from cramps, the mean PTH level was significantly lower than that of the group that did not suffer from cramps, 37.2±48.9 and 48.9±3.5, respectively (P=0.0002).

Table 2: Positive and Negative Correlations

	P-value
Positive Correlations	
Serum Mg level and pre-dialysis DBP	0.016
Serum Mg level and pre-dialysis BP	0.05
Pre-dialysis DBP and weight gain	0.0029
Age and post SBP	0.007
Negative Correlations	
Age and pre-dialysis DBP	0.005
Weight gain	0.02

The mean differences between those who developed symptomatic hypotension and those who did not in pre-dialysis DBP, post-dialysis SBP, and post-dialysis SBP were 14.7 (P=0.003), 22 (P=0.001) and 15.8 (P=0.001mmHg), see table 3.

Table 3: The Mean BP Levels in Those with and without Symptomatic Hypotension

	Symptomatic Hypotension	Mean±Std	P-value
Pre-dialysis Diastolic BP	Yes	52.4±11.4	0.003
	No	67.1±18.7	
Post-dialysis Systolic BP	Yes	116.4±24.4	0.001
	No	138.4±23.8	
Post-dialysis Diastolic BP	Yes	52.5±13.0	0.0001
	No	68.3±16.7	

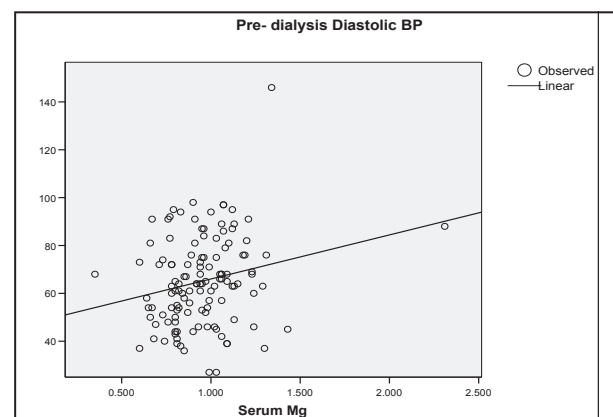


Figure 1: Correlation between Pre-Dialysis DBP and Serum Mg

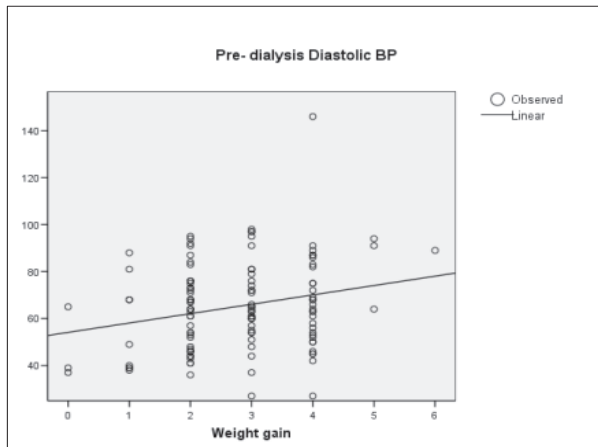


Figure 2: Correlation between Pre-Dialysis DBP and Interdialytic Weight Gain

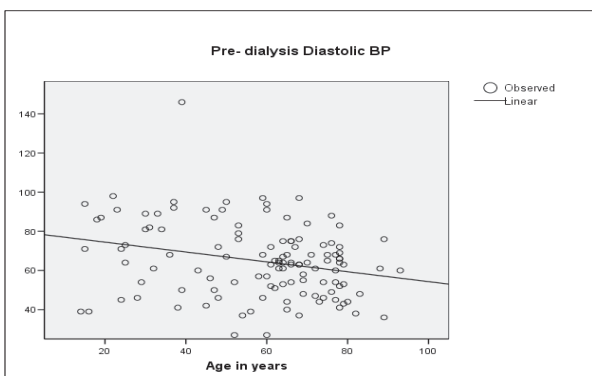


Figure 3: Correlation between Pre-Dialysis DBP and Age

DISCUSSION

Low Mg level has been reported to be associated with increased mortality in hemodialysis patients; however, this was mostly due to non-cardiovascular causes and may be related to low Mg causing enhanced inflammatory responses¹⁰⁻¹².

In this study, intradialytic cramps occurred in 13.6%. This was less than the reported prevalence of 25%¹³.

We found that in those who suffered from cramps, the PTH level was significantly lower compared to those who did not, as reported previously¹⁴.

Low magnesium level has been reported to be associated with cramps according to Holley et al¹⁴. Raising Mg concentration in the dialysis fluid from 0.375 mmol/L to 0.50 mmol/l reduced the occurrence of muscle cramps by 21%^{4,15}.

In our study, we found no correlation between Mg level and cramps. Symptomatic hypotension was observed in 12.6% of our patients. It has been shown to occur in 20-30% of dialysis sessions¹⁶. This is consistent with reports that higher Mg concentration in the dialysis fluid reduces the incidence of intradialytic hypotension. It is an important consideration as symptomatic hypotension is associated with increased mortality^{17,18}.

Furthermore, we found a significant positive correlation between serum Mg levels and pre-dialysis DBP ($P=0.016$) and pre-dialysis SBP ($P=0.05$). It could be due to that serum Mg plays an important physiological role in cardiac function, cardiac stability and vascular tonicity.

The mean differences between those who developed symptomatic hypotension and those who did not in pre-dialysis DBP, post-dialysis SBP, and post-dialysis SBP were 14.7 ($P=0.003$), 22 ($P=0.001$) and 15.8 ($P=0.001$) mmHg, respectively.

A significant positive correlation was found between pre-dialysis DBP and weight gain ($P=0.0029$); this has been well established in previous studies¹⁹. This report also showed that patient's age was positively correlated with post SBP and negatively associated with pre-dialysis DBP and weight gain.

We found no correlation between Mg level and age, sex and dialysis vintage, cramps or hypotension, Ca or PTH level; although it has been established that in healthy individuals, PTH increases Mg level by increasing its gastrointestinal absorption, bone resorption and renal reabsorption. On the other hand, Mg is essential for synthesis, release, and adequate tissue sensitivity of PTH⁴.

CONCLUSION

Mg level was associated with higher BP levels. Lower PTH level was observed in patients who suffered from cramps. Age was positively correlated with post SBP and negatively associated with pre-dialysis DBP and weight gain.

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