HYPOMAGNESEMIA IN PERITONEAL DIALYSIS - PREVALENCE, CLINICAL ASSOCIATIONS AND MAGNESIUM BALANCE

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INTRODUTION Lower serum magnesium (SMg) is associated to worse outcomes in dialysis patients (1-4), although pathological mechanisms are not clear. Magnesium deficit seem to induce an inflammatory response in animal models (5) and is associated to higher c-reactive protein in general population (6). SMg represents only 1% of total magnesium and could not be the best marker of magnesium stores. Intra-erythrocyte Mg (EMg) is presumably a better marker of body stores than serum Mg (7). We hypothesized that dialysis prescription, such as solution composition and diuretic use, could change magnesium balance with biological impact.

AIM: 1) determine hypomagnesemia prevalence by both SMg/EMg methods; 2) explore correlation with comorbidity, nutrition and inflammation; 3) investigate magnesium (SMg and EMg) association with transport rate, dialysis schedule, ultrafiltration, residual renal function (RRF) and peritoneal magnesium removal and urinary magnesium.

METHODS -> Cross-sectional study of all stable peritoneal dialysis patients follow for at least 3 months. Phosphate binders without Mg were used.
-> They were dialyzed under low-GDPs PD solutions, 56% bicarbonate/lactate Baxter (Mg 0.25 mmol/l), 44% lactate Fresenius (Mg 0.5 mmol/l).
-> Hypertonic dialysis – it is used more than 1 solution with glucose ≥ [2.5%]
-> Clinical variables, labs (inflammation, nutrition and fosfocalcium metabolism) bioimpedance and dialysis prescription were evaluated.
-> Daily urinary Mg (UMg) and daily Peritoneal Mg Flux (mmol/24h) (PMF) were measured and a subgroup of 40 pts underwent.
-> Flux (mmol/exchange) = (Di x Vi) - (Do x Vo), Di and Do are the dialysate Mg concentration in the inflow and outflow (mmol/L) and Vi and Vo are the dialysate inflow and outflow volumes (L), negative values reflecting peritoneal removal.
-> Statistical analysis used SPSS 20.0, p values less than 0.05 were considered significant.
-> Explored the association of the variables with SMg and EMg. In statistic significant associations we did multivariate analysis by linear regression.

RESULTS

Table1 – Patients characteristics

Variável	Total (n=52)
Age (years)	51 (41-62)
Male	27 (52)
Peritoneal dialysis vintage (m)	22 (13-52)
Charson Comorbility Score	3 (2-4)
Diabetes	6 (11.3)
Proton Bomb inibitors	33 (60.4)
CAPD/ADP	29 (54.7)/23 (43.4)
Anuric	12 (22.6)
Fresenius/Baxter	23 (44)/29 (56)
Icodextrin	27 (51.9)
Hypertonic dialysis	41 (77.4)
Daily exchange volume (L)	8.72 (5.8-12.8)
Daily ultrafiltration (L)	1.29 (1-1.8)
Peritoneal Kt/V	1.37 (1.12-1.74)
Daily urine voluem (L)	0.85 (0.23-1.28)
Daily furosemida (mg)	160 (80-240) n=40
RRF (mL/min/1.73 m²)	3.06 (0.74-5.84)
SMg (mmol/L)	0.9 (0.78-1)
Hypo/Hyper	1 (1.9)/4 (7.7)
EMg (mmol/L)	2.7 (2.4-3)
Hypo/Hyper	1 (1.9)/26 (50)
UMg (mmol/24h)	1.15 (0.5-1.8)
Perit Mg Flux (mmol/24h)	-1.99 (-2.65-(-1.43))
nPNA (g/kg/day)	1.06 (0.89-1.3)
Albumin (g/dL)	4 (3.8-4.2)
Creatinine (mg/dL)	8.7 (6.8-12.1)
C-reactive protein (mg/dL)	3.2 (0.7-9.3)
Calcium (mmol/L)	2.2 (2-2.3)
Phosphorus (mmol/L)	1.5 (1.29-1.9)
PTH (pg/mL)	521.4 (303.5 – 665.5)
Body Mass index (kg/m²)	26.1 (22.85 – 29.1)
Lean tissue index (kg/m²)	12.6 (11.5-15.4)
Fat tissue index (kg/m²)	11.4 (8.7-16.3)
Intra-celular water (L)	18.9 (15.2-21.5)
Extra-celular water (L)	17.1 (14.1-18.9)
Body cell mass (Kg)	19.6 (15.6-26.3)

Table 2 – SMg and EMg according to categorical variables

Variable	SMg	p value	EMg	p value
Male	0.9 (0.7-1)	ns	2.9 (2.6-3.2)	ns
Female	0.9 (0.78-1)		2.6 (2.4-2.8)	
Diabetes				
Yes	0.9 (0.73-1)	ns	2.8 (2.4-3.3)	ns
No	0.9 (0.74-1)		2.7 (2.4-3)	
Anuric				
Yes	0.9 (0.7-1.1)	ns	2.7 (2.4-3)	ns
No	0.9 (0.8-1)		2.7 (2.4-3.4)	
CAPD	0.8 (0.7-0.9)	ns	2.7 (2.4-3)	ns
APD	0.9 (0.79-1.03)		2.7 (2.5-3.2)	
Fresenius	**0.9 (0.8-1.1)**	0.028	2.7 (2.4-3.1)	ns
Baxter	**0.8 (0.7-0.9)**		2.7 (2.6-3)	
Icodextrin				
Yes	0.8 (0.7-0.9)	ns	2.8 (2.6-3)	ns
No	0.9 (0.8-1.03)		2.6 (2.4-3)	
≥2.5% glicose				
Yes	0.9 (0.8-1)	ns	2.8 (2.5-3)	ns
No	0.8 (0.7-0.9)		2.6 (2.2-2.9)	

Table 3 – Correlation with SMg and EMg

Variable	SMg		EMg	
	R2	p value	R2	p value
Age (years)	-0.11	ns	-0.253	ns
Peritoneal dialysis vintage(m)	-0.093	ns	0.063	ns
Charson Comorbility Score	-0.093	ns	-0.147	ns
Daily exchange volume (L)	0.083	ns	**0.301**	0.032
Daily ultrafiltration (L)	0.086	ns	0.02	ns
Peritoneal Kt/V	0.206	ns	0.195	ns
Daily urine volume (L)	-0.153	ns	-0.221	ns
Daily furosemide (mg)	-0.004	ns	-0.089	ns
RRF (mL/min/1.73m²)	-0.11	ns	**-0.286**	0.040
SMg (mmol/L)	-	-	**0.464**	0.001
EMg (mmol/L)	**0.464**	0.001	-	-
UMg (mmol/24h)	0.112	ns	0.055	ns
Perit Mg Flux (mmol/24h)	**-0.508**	0.001	**-0.753**	<0.001
nPNA (g/kg/day)	0.066	ns	0.128	ns
Albumin (g/dL)	0.104	ns	0.204	ns
Creatinine (mg/dL)	0.242	ns	**0.461**	0.001
C-reactive protein (mg/dL)	0.118	ns	-0.044	ns
Ferritine (ng/dL)	0.057	ns	-0.024	ns
Calcium (mmol/L)	0.193	ns	-0.01	ns
Phosphorus (mmol/L)	**0.302**	0.033	**0.502**	<0.001
PTH (pg/mL)	-0.237	ns	0.047	ns
Lean tissue index (kg/m²)	-0.011	ns	**0.282**	0.043
Fat tissue index (kg/m²)	-0.09	ns	-0.043	ns
Intra-celular water (L)	-0.134	ns	**0.227**	0.047
Extra-celular water (L)	-0.253	0.071	0.174	ns
Body cell mass (Kg)	-0.071	ns	**0.267**	0.056

Table 4 – Multivariate model for predictor factor for EMg
(linear regression- R2=0.630, constant=0.488, p<0.001, n=40)

Variable	B coeficient	p value
RRF	-0.314	0.172
Fresenius/Baxter	-0.226	0.823
Daily exchange volume (L)	-0.141	0.494
Creatinine (mg/dL)	-0.162	0.503
Phosphorus (mmol/L)	0.274	0.121
Lean tissue index (kg/m²)	0.071	0.881
Intra-celular water (L)	0.218	0.678
Body Cell Mass (Kg)	0.047	0.953
SMg (mmol/L)	0.304	0.076
Perit Mg Flux (mmol/24h)	-0.409	**0.028**

All variables included in the model were found to be significant in the univariate analysis except for the type solution used that was forced to the model.

Table 5 – Multivariate model for predictor factor for SMg
(linear regression - R2=0.489, constant=0.502, p value<0.001, n=40)

Variable	B coeficient	p value
EMg (mmol/L)	0.262	0.153
Fresenius/Baxter	0.468	**0.001**
Phosphorus (mmol/L)	-0.005	0.970
Daily exchange volume (L)	-0.116	0.522
Perit Mg Flux (mmol/24h)	-0.476	**0.016**

All variables included in the model were found to be significant in the univariate analysis except for the daily exchange volume that was forced to the model

DISCUSSION/CONCLUSION

- Hypomagnesaemia was infrequent in our population with both SMg and EMg. HyperMg was more frequent with EMg.
- EMg seems to better reflect the expected associations with nutritional parameters but was not associated with comorbidity or inflammation.
- The use of solutions with [Mg] 0.5mmol/L (Fresenius) versus 0.25mmol/L (Baxter) was associated with higher levels of SMg but not EMg. This result was also described in other studies (7).
- Ultrafiltration, hypertonic dialysis (≥2.5% glucose) or the use of icodextrin do not seem to influence magnesium levels, although hypertonic dialysis has been identified as a risk factor for hypomagnesaemia in another study (402 CAPD patients) (8).
- SMg and EMg were independently associated with the peritoneal magnesium flux. More negative peritoneal magnesium flux (higher magnesium extraction) the higher SMg/EMg.
- Peritoneal Mg diffusive removal is significantly related with SMg/EMg.

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