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COMPARED VALUES OF URINARY AND PERITONEAL FRACTIONAL EXCRETION OF MAGNESIUM AND PHOSPHORUS AMONG PATIENTS ON PERITONEAL DIALYSIS WITH RESIDUAL DIURESIS, CHRONIC RENAL FAILURE (STAGE III) AND HEALTHY VOLUNTEERS

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SUMMARY:

Background: Magnesium and phosphorus are one of the electrolytes whose balance is altered during advanced chronic renal failure (CRD-V). It has already been reported in the literature that there is a progressive increase in urinary electrolyte excretion in CRD-V in relation with the glomerular filtration rate reduction, but it has not been extensively studied yet for these divalent ions.

Therefore we decided to perform a study for evaluating compared values of urinary and peritoneal fractional excretion of these divalent ions (magnesium and phosphorus) among patients on peritoneal dialysis with residual diuresis (CRD-V), stage III - chronic renal failure, and healthy volunteers.

Results: Urinary fractional excretion (FEu) of magnesium (Mg) and phosphorus (P) were significantly ($p < 0.05$) lower in healthy volunteers (FEuMg: $3 \pm 1\%$, FEuP: $9 \pm 0.5\%$), and significantly higher in CRD-V (FEuMg: $30 \pm 4\%$, FEuP: $40 \pm 0.2\%$). Regarding peritoneal fractional excretion (FEp) of magnesium and phosphorus, they were significantly higher ($p < 0.05$) (FEpMg: $36 \pm 5\%$, FEpP: $62 \pm 9\%$) than the urinary ones in the same population: CRD-V.

Conclusion: Magnesium and phosphorus urinary fractional excretion values were significantly higher in the CRD-V group, while these values were significantly lower than the peritoneal ones in the same population: CRD-V.

KEYWORDS: Magnesium. Phosphorus. Peritoneal Dialysis.

RESUMEN:

Introducción: Entre los electrolitos que pueden alterarse en la insuficiencia renal crónica avanzada se encuentran el magnesio y el fósforo. Asimismo, se ha reportado en la literatura que en la nefropatía crónica existe un progresivo incremento en la excreción fraccional de los electrolitos a medida que se reduce el filtrado glomerular, sin embargo esto no ha sido estudiado en profundidad aun para estos iones divalentes.

Por esta razón, se decidió realizar entonces un estudio a fin de evaluar los valores comparados de excreción fraccional de magnesio y fósforo peritoneal y urinario entre pacientes en diálisis peritoneal con diuresis residual (ERC-V), insuficiencia renal crónica (estadio III) y voluntarios sanos.

Resultados: Los valores de excreción fraccional urinaria (EFu) de magnesio (Mg) y fósforo (P) fueron significativamente ($p < 0.05$) más bajos en los voluntarios sanos (EFuMg: $3 \pm 1\%$, EFuP: $9 \pm 0.5\%$), y significativamente más altos en los ERC-V (EFuMg: $30 \pm 4\%$, EFuP: $40 \pm 0.2\%$).

En cuanto a la excreción fraccional peritoneal (EFp) del fósforo y del magnesio, ésta fue significativamente ($p < 0.05$) más alta (EFpMg: $36 \pm 5\%$, EFpP: $62 \pm 9\%$) que aquella lograda por vía urinaria en el mismo grupo: ERC-V.

Conclusión: Los valores de excreción fraccional urinaria de magnesio y fósforo fueron significativamente más elevados en los portadores de nefropatía crónica avanzada (ERC-V), siendo a su vez dichos valores significativamente más bajos que aquellos logrados por la excreción fraccional peritoneal de dichos iones divalentes en la misma población: ERC-V.

PALABRAS CLAVE: Magnesio. Fósforo. Diálisis peritoneal.

INTRODUCTION

Magnesium and phosphorus are one of the divalent ions whose balance can be altered in the advanced chronic renal failure¹⁻².

It has already been reported in the literature, that there is a progressive increase in urinary electrolyte excretion in relation to the glomerular filtration rate reduction in chronic renal disease patients, but it has not been extensively studied yet in these divalent ions²⁻³.

Therefore we had the question of studying compared values of urinary and peritoneal fractional excretion of these divalent ions (magnesium and phosphorus) among patients on peritoneal dialysis with residual diuresis (stage V - chronic renal disease), stage III - chronic renal failure, and healthy volunteers.

MATERIAL AND METHODS

Nineteen adult patients on out-patient peritoneal dialysis who had the same type of peritoneal membrane (average), glucose concentration (2.3%) and magnesium (0.75 mmol/l) in the solution bag, dialysis scheme, residual glomerular filtration (8 ml/min/1.73 m²), diet, magnesemia and phosphatemia values, were studied. Serum, urinary and peritoneal magnesium and phosphorus values were obtained from each peritoneal dialysis volunteer.

Besides, serum and urinary magnesium and phosphorus were measured in 20 patients with chronic renal failure (stage III) as well as in 10 healthy volunteers.

In all of them fractional excretion of urinary (FEu) and peritoneal (FEp) magnesium (Mg) and phosphorus (P) were calculated applying the following formula:

- Urinary fractional excretion (FEu):
[urinary α (mg/dl) x serum creatinine (mg/dl) / serum α (mg/dl) x urinary creatinine (mg/dl)] x 100
 - Peritoneal fractional excretion (FEp):
[peritoneal α (mg/dl) x serum creatinine (mg/dl) / serum α (mg/dl) x urinary creatinine (mg/dl)] x 100
- α : magnesium or phosphorus

All the obtained values were adjusted according to divalent ions diffusible fraction (magnesium and phosphorus: 0.8), and to magnesium content in the peritoneal bag⁴⁻⁵.

Statistical Analysis was performed applying Wilcoxon test.

RESULTS

No significantly statistical difference was documented in the serum magnesium and phosphorus values among the studied groups: healthy, stage III-chronic renal disease (CRD-III), and peritoneal dialysis: stage V- chronic renal disease(CRD-V) (Table 1).

Table 1: Serum magnesium (MGs) and phosphorus (P) values among normal, stage III chronic renal disease (CRD-III), and stage V chronic renal disease (CRD-V)

	Normal	CRD-III	CRD-V	P
MGs (mg/dl)	2.1 ± 0.1	2.3 ± 0.2	2.3 ± 0.5	NS
Ps (mg/dl)	4.7 ± 2	4.5 ± 2	4.5 ± 1	NS

Conversely, a significantly statistical difference was documented in the urinary and peritoneal fractional excretion values among the above mentioned three studied groups (Table 2).

Table 2: Urinary (FEu) and peritoneal (EFp) fractional excretion of magnesium (MG) and phosphorus (P) among normal, stage III - chronic renal disease (CRD-III) and stage V - chronic renal disease (CRD-V)

	Normal	CRD-III	CRD-V	p
FeuMG (%)	3 ± 1	7.2 ± 4	30 ± 4	< 0.05
FepMG (%)	--	--	36 ± 5	< 0.05
FeuP (%)	9 ± 0.5	25 ± 0.9	40 ± 0.2	< 0.05
FepP (%)	--	--	62 ± 9	< 0.05

DISCUSSION:

In this study, there was no significant difference in serum magnesium and phosphorus values among the three studied groups (CRF in stage V, CRF stage III, healthy people), while it was found that there was a significantly statistical difference in urinary and peritoneal fractional excretion of magnesium (EFMg) and fractional excretion of phosphorus (EFP) among the studied groups.

Regarding the urinary fractional excretion values of these divalent ions, they were significantly lower in the healthy volunteers, and higher in those who suffered from the more advance chronic renal disease (CRD-V). This finding reflects the known physiological fact of the progressive renal adaptation in the handling of magnesium and phosphorus in terms of the drop in glomerular filtration rate⁶.

Regarding the peritoneal fractional excretion values of the magnesium and phosphorus, they were significantly higher compared with the urinary ones in the same population (CRD-V). This finding reinforces the concept that peritoneal and urinary filtration rate are not physiologically equal phenomena⁷.

CONCLUSION:

In this study was documented that urinary fractional excretion values of magnesium and phosphorus were significantly lower in healthy volunteers and higher in stage V-chronic renal disease, and that peritoneal fractional excretion values of these divalent ions were higher than the urinary ones.

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The paper of Musso et al, shows more data about the adaptive physio-pathologic mechanisms of kidney in chronic renal disease and it is specially interesting, the data about the peritoneal membranous behavior, in patients with stage 5 renal chronic disease, that proves to be different to the kidney.

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Un estudio muy interesante; con los resultados de este trabajo se confirma la fisiología ocurrida en el riñón a medida que progresa la enfermedad renal y desciende el filtrado glomerular (FG). A medida que avanza la enfermedad renal, la capacidad tubular de eliminar fósforo (P) desciende, si hablamos en términos de pool total, sin embargo, si es la excreción fraccional urinaria de fósforo (EFuP) lo que medimos, ocurre efectivamente lo que ilustra el presente trabajo, que aumenta.

Se explica así como en los resultados del presente trabajo, la EFuP en voluntarios sanos, fuera significativamente ($p < 0.05$) más baja (EFuP: $9 \pm 0.5\%$), que en los enfermos renales crónicos estadio V (ERC-V) (EFuP: $40 \pm 0.2\%$). Lo mismo ocurre con la eliminación de magnesio (Mg), si atendemos a la EFuMg y no al pool total eliminado de Mg, efectivamente, la EFuMg en sanos (EFuMg: $3 \pm 1\%$) es menor que en ERC-V (EFuMg: $30 \pm 4\%$).

Actualmente cobra mucha importancia el papel que desempeña el P en el enfermo renal, como uno de los marcadores que inicialmente se elevan en la progresión de la enfermedad renal (antes que la propia PTH y que el propio descenso del FG). Se sabe que a medida que progresa la enfermedad renal, se produce un descenso en la excreción urinaria de P total, entre otros factores por déficit de FGF 23 y de su cofactor el Klotho, produciéndose un incremento en los niveles de P en sangre. Esta elevación de P en sangre (por parte del hueso y del riñón), estimula a su vez de forma independiente la secreción de PTH, incrementando en mayor medida la resorción ósea y a su vez los niveles de P séricos a medida que avanza la enfermedad renal.

En este trabajo también se analiza la excreción fraccional peritoneal del fósforo (EFpP) y Mg (EFpMg). El hecho de que la EFp del fósforo fuese significativamente ($p < 0.05$) más alta (EFpP: $62 \pm 9\%$) que la excreción fraccional urinaria de fósforo en la misma población, apoya el hecho de que los pacientes en diálisis peritoneal, a pesar de tener poca diuresis residual, consigan un mejor control del P sérico con respecto a la población de hemodiálisis, quizás ayudado por esta eliminación peritoneal, entre otros factores.



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