

Muscle intracellular free [Mg²⁺] assessed by ³¹P MRS in patients with Chronic Intestinal Failure on long-term Home Parenteral Nutrition

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Introduction.

Intravenous infusion of nutrients is a non physiological way of nutritional support. In patients receiving long-term Home Parenteral Nutrition (HPN), subclinical deficiency of nutrients may persist and metabolic complications may develop (1). Both may be due to the underlying disease as well as to the HPN. Magnesium (Mg) and potassium (K) deficiencies (2) are among the most frequent issues (3,4). Low serum concentrations of Mg and K have been reported in 2-30% of patients receiving intravenous magnesium with home parenteral nutrition (2). Furthermore, low concentrations of magnesium in red blood cells have been observed in about 30% of the patients on HPN having normal serum magnesium levels (5).

³¹P MRS has shown to be a valuable tool to assess non-invasively free intracellular [Mg²⁺] in skeletal muscle (6). In this study we assessed free intracellular [Mg²⁺] by ³¹P MRS in the skeletal muscle of patients on long-term Home Parenteral Nutrition affected by Chronic Intestinal Failure (CIF).

We compared the content of muscle free [Mg²⁺] assessed by ³¹P MRS to that of serum total Mg routinely assessed in these patients by colorimetric assays. Moreover, since Mg is known to play a role in the regulation of parathyroid hormone (PTH) secretion and function (7), we also investigated how muscle free Mg²⁺ and serum total Mg correlates with PTH serum content.

Methods. We studied 21 patients with CIF (age 44 ± 14; 11 M, 10 F) receiving long-term HPN. Informed consent was obtained from each patient. In each patient ³¹P MRS was performed and blood samples collected 6 hours after stopping the nocturnal HPN. ³¹P MRS was performed using a 1.5T General Electrics Medical Systems (Milwaukee, Wisconsin) Signa Horizon LX whole-body scanner. Spectra were acquired from the right calf muscle of patients laying supine in the magnet by a surface coil with a TR of 5 s. Sixty-four FIDs at rest were averaged. Spectra were post-processed by a time-domain fitting routine AMARES/MRUI (<http://carbon.uab.es/mrui>). Muscle free intracellular [Mg²⁺] was assessed by the chemical shift of β-ATP and Pi from PCr by using a specific equation implemented in the software "Magic-BMC" (6). Total serum Mg and serum PTH were assessed by routine colorimetric and immunochemiluminometric assays (ICMA) respectively. Control values were expressed as mean ± 2 SD and taken: (A) by a sample of 50 healthy control subjects for muscle free [Mg²⁺]; and (B) by the hospital laboratory routine normal range.

Result and Discussion. Patients intracellular free [Mg²⁺] was normal in the calf muscle (Figure 1A) despite about 30% of patients had a content of total serum Mg below the reference range (Figure 1B). Muscle free [Mg²⁺] displayed a significant positive correlation (p = 0.01) while serum total Mg showed a significant negative correlation (p = 0.0003) with serum PTH content. The free intracellular Mg²⁺ assessed by ³¹P MRS in skeletal muscles showed to be more consistent with the patients electrolytic status than that of serum total Mg assessed by conventional routine methods. The correlation of different sign displayed by muscle free Mg²⁺ and serum total Mg versus serum PTH, is a prove of the different functional meaning of the Mg present in the two compartments, providing also evidences that ³¹P MRS is a valuable tool for the *in vivo* assessment of free intracellular [Mg²⁺] in human skeletal muscle.

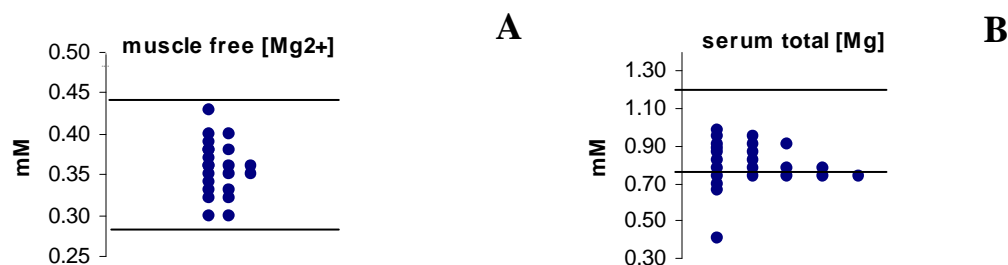


Figure 1. Magnesium content in 21 CIF patients. (A) muscle free [Mg²⁺] assessed by ³¹P MRS; (B) total serum Mg assessed by colorimetric essays. Solid lines represents the boundary limits of control values obtained in healthy subjects (mean ± 2 SD).

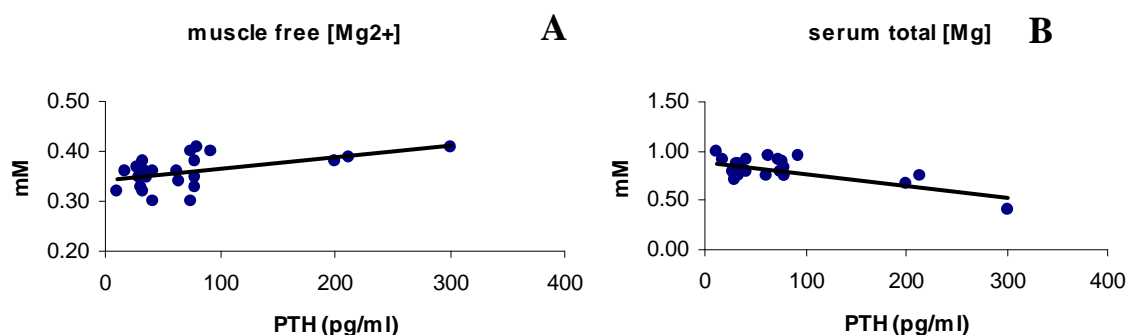


Figure 2. Magnesium correlations with serum PTH in 21 CIF patients. (A) muscle free [Mg²⁺] assessed by ³¹P MRS; (B) total serum Mg assessed by colorimetric essays.

References

1. Byrne JU, et al. *JPEN*; 16: 327,1992
2. Seidner DL, et al. *NCP* 15:163, 2000;
3. Pironi L et al. *Clin Nutr*. 21:289, 2002
4. Da Pont MC, et al. *Clin Nutr* 21:67, 2002
5. Kayne LH, and Lee DBN. *Miner Electrolyte Metab* 19:210, 1993
6. Iotti S. et al. *Magn Reson Imag* 18, 607, 2000
7. Fatemi S. et al. *J. Clin. Endocrinol. Metab.* 73, 1067 1991