

SHORT COMMUNICATION

Vitamin D and magnesium absorption in man

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Summary

1. The effects of vitamin D and its hydroxylated derivatives on calcium and magnesium absorption have been examined in 47 balance studies on patients with various disorders of calcium or bone metabolism.

2. Vitamin D significantly increased the mean net absorption of calcium and also the calcium balance. The mean net absorption of magnesium was also significantly increased although the rise was much less than that of calcium and the mean magnesium balance was unaffected.

3. It is suggested that the slight effect of vitamin D on magnesium absorption may be incidental to its stimulation of active calcium transport, since the latter system has weak affinities for other alkaline earth ions including strontium, barium and magnesium.

Key words: absorption, calcium, magnesium, vitamin D.

Introduction

There appears to be no factor which affects the absorption of magnesium as vitamin D does that of calcium. However, animal studies suggest that vitamin D does promote magnesium absorption to some extent. Thus Outhouse, Smith & Twomey (1938), Meintzer & Steenbock (1955) and Jacob & Forbes (1970) showed in balance studies on rats that magnesium absorption was increased by

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providing physiological amounts of vitamin D. Small amounts of vitamin D also enhanced magnesium absorption in the chick (Worker & Migicovsky, 1961) and the pig (Miller, Ullrey, Zutaut, Hoefler & Leucke, 1965).

There have been only a few studies in man. McCane (1947) and Anast (1967) reported an increase in magnesium absorption when large doses of vitamin D were given to two patients with vitamin D-resistant rickets, and Eliel, Smith & Thomsen (1960) showed that vitamin D increased magnesium absorption in an alcoholic patient. However, an earlier study in this laboratory on seven patients with osteomalacia or osteoporosis yielded equivocal results, magnesium absorption apparently increasing in some patients but not in others (Heaton, Hodgkinson & Rose, 1964).

In the present paper we describe the results of a more extensive study of the effects of vitamin D and its hydroxylated derivatives on the absorption of calcium and magnesium, by using an improved balance technique.

Patients and methods

The subjects included five men and 13 women with osteoporosis, one man and six women with osteomalacia, four women with primary hyperparathyroidism, one woman with hypoparathyroidism and two normal women.

Seven-day metabolic balances were carried out as described by Nordin (1976). Each patient received a diet that was constant in calcium, phosphorus and magnesium content (about 800 mg of Ca, 1200 mg of P and 250 mg of Mg daily) and a

preliminary period of 7 days was allowed for equilibration. The balances were repeated, on the same diets, 1–6 months after commencing treatment with vitamin D₂ (calciferol, 1000–10 000 units daily), 25-hydroxycholecalciferol (25-OHD₃, 0.5 mg daily), 1 α ,25-dihydroxycholecalciferol [1,25-(OH)₂D₃, 1–2 μ g daily] or 1 α -hydroxycholecalciferol (1 α -OHD₃, 0.5–5 μ g daily).

Calcium and magnesium were determined by atomic absorption spectrophotometry (Instrumentation Laboratories model 353 Atomic Absorption/Emission Spectrophotometer). The net absorption of calcium and magnesium is the difference between the daily dietary intake and the daily faecal excretion of these elements. The significance of the differences between mean net absorption, urinary excretion or net balance before and during treatment were assessed by means of Student's paired *t*-test.

Results

The effects of vitamin D and of its hydroxylated derivatives on net absorption, urinary excretion and

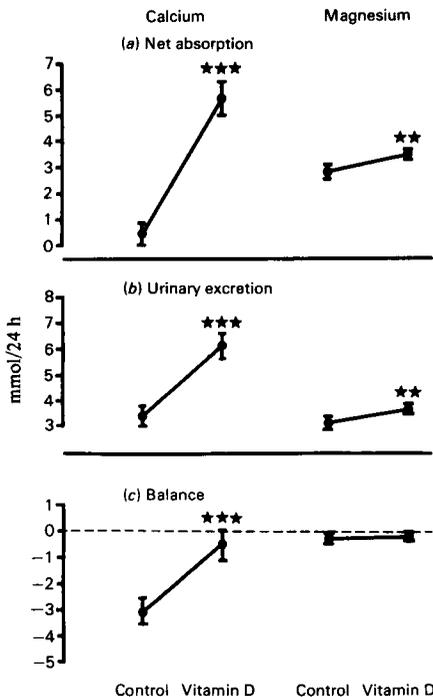


FIG. 1. Effect of vitamin D and its hydroxylated derivatives on (a) mean net absorption, (b) urinary excretion and (c) net balance of calcium and magnesium in 32 patients with various bone or endocrine disorders. The vertical bars denote ± 1 SEM: ** $P < 0.01$; *** $P < 0.001$.

net balance of calcium and magnesium are summarized in Fig. 1. The experimental points indicate the mean values obtained in 47 control balance periods and 47 test balance periods.

Most of the patients had a low net absorption of calcium before treatment (normal about 5 mmol/day) and were in strongly negative calcium balance. Treatment resulted in a significant rise in the mean net absorption of calcium and in the mean calcium balance. There was also a significant rise in the urinary excretion of calcium.

By contrast, most of the patients had a normal net absorption of magnesium before treatment and they were in magnesium balance. Treatment resulted in a small and significant increase in net magnesium absorption and in the urinary excretion of magnesium but the mean magnesium balance remained unchanged.

Responses to the different vitamin D derivatives were qualitatively similar, as also were the responses in the different disorders studied. However, the numbers of patients in each subgroup were too small to permit further statistical analysis.

Discussion

These results confirm that vitamin D, and its hydroxylated derivatives, significantly increase the net absorption of magnesium but the effect is small compared with that on calcium absorption, the molar ratio of the increase in magnesium absorption to the increase in calcium absorption being 0.114. The difference might be due to the fact that most of the patients had impaired calcium absorption before treatment whereas magnesium absorption was normal, but this explanation appears to be unlikely since vitamin D, and also 1,25-dihydroxycholecalciferol, significantly increase calcium absorption, even in normal subjects (Coburn, Brickman, Kurokawa, Massry, Bethune, Harrison & Norman, 1974). The smaller effect of vitamin D on magnesium absorption compared with calcium absorption therefore appears to be real and not a consequence of the experimental conditions.

The mechanisms involved in the intestinal absorption of magnesium are still not fully understood, but present evidence indicates that absorption occurs mainly by passive or 'facilitated' diffusion (Wilkinson, 1976). The small effect of vitamin D on magnesium absorption might be secondary to its effect on calcium absorption, an increased absorption of calcium leading to a reduced concentration of calcium in the intestine

and hence to reduced competition by calcium for a common transport system. However, no significant relation could be found between net magnesium absorption and the faecal excretion of calcium, so that this explanation appears to be unlikely.

A further possibility is that the active component of calcium transport, which is enhanced by vitamin D, also has a weak affinity for magnesium. It has been shown, for example, that the calcium-binding protein intimately associated with calcium absorption will bind other alkaline earth ions in the following decreasing order of affinity: Ca > Sr > Ba > Mg; moreover, this is the order of relative effectiveness of vitamin D in enhancing the intestinal absorption of these ions in the chick (Taylor & Wasserman, 1974).

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