

Reduction of dietary magnesium by only 50% in the rat disrupts bone and mineral metabolism.

[Osteoporos Int.](#) 2006;17(7):1022-32. Epub 2006 Apr 7.

Rude RK1, Gruber HE, Norton HJ, Wei LY, Frausto A, Kilburn J.

Author information:

1University of Southern California and the Orthopaedic Hospital, 1975 Zonal Ave., GNH 6602, Los Angeles, CA 90089-9317, USA.

rrude60075@aol.com

Abstract

INTRODUCTION:

The objective of this study was to determine the effect of a moderate reduction of dietary magnesium [50% of nutrient requirement (50% NR)] on bone and mineral metabolism in the rat, and to explore possible mechanisms for the resultant reduced bone mass.

METHODS:

Female rats were 6 weeks of age at the start of study. Serum magnesium (Mg), calcium (Ca), parathyroid hormone (PTH), 1,25(OH)(2)-vitamin D, alkaline phosphatase, osteocalcin, and pyridinoline were measured during the study at 3- and 6-month time points in control (dietary Mg of 100% NR) and Mg-deficient animals (dietary Mg at 50% NR). Femurs and tibias were also collected for mineral content analyses, micro-computerized tomography, histomorphometry, and immunohistochemical localization of substance P, TNFalpha, and IL-1beta at 3 and 6 months.

RESULTS:

Although no significant change in serum Mg was observed, Mg deficiency developed, as assessed by the reduction in bone Mg content at the 3- and 6-month time points (0.69±0.05 and 0.62±0.04% ash, respectively, in the Mg depletion group compared to 0.74±0.04 and 0.67±0.04% ash, respectively, in the control group; p=0.0009). Hypercalcemia did not develop. Although serum Ca level remained in the normal range, it fell significantly with Mg depletion at 3 and 6 months (10.4±0.3 and 9.6±0.3 mg/dl, respectively, compared to 10.5±0.4 and 10.1±0.6 mg/dl, respectively, in the control group; p=0.0076). The fall in serum Ca in the Mg-depleted animals was associated with a fall in serum PTH concentration between 3 and 6 months (603±286 and 505±302 pg/ml, respectively, although it was still higher than the control). The serum 1,25(OH)(2)-vitamin D level was significantly lower in the Mg depletion group at 6 months (10.6±7.1 pg/ml) than in the control (23.5±12.7 pg/ml) (p<0.01 by the t-test). In Mg-deficient animals, no difference was noted in markers of bone turnover. Trabecular bone mineral content gain was less over time in the distal femur with Mg deficiency at 3 and 6 months (0.028±0.005 and 0.038±0.007 g, respectively, compared to 0.027±0.004 and 0.048±0.006 g, respectively, in the control group; p<0.005). Histomorphometry at these time points

demonstrated decreased trabecular bone volume (15.76 \pm 1.93 and 14.19 \pm 1.85%, respectively, compared to 19.24 \pm 3.10 and 17.30 \pm 2.59%, respectively, in the control group; p=0.001). Osteoclast number was also significantly increased with Mg depletion (9.07 \pm 1.21 and 13.84 \pm 2.06, respectively, compared to 7.02 \pm 1.89 and 10.47 \pm 1.33, respectively, in the control group; p=0.0003). Relative to the control, immunohistochemical staining intensity of the neurotransmitter substance P and of the cytokines TNF α and IL-1 β was increased in cells of the bone microenvironment in the Mg depletion group, suggesting that inflammatory cytokines may contribute to bone loss.

CONCLUSION:

These data demonstrate that Mg intake of 50% NR in the rat causes a reduced bone mineral content and reduced volume of the distal femur. These changes may be related to altered PTH and 1,25(OH) $_2$ -vitamin D formation or action as well as to an increase release of substance P and the inflammatory cytokines TNF α and IL-1 β .