Orthosilicic acid stimulates collagen type 1 synthesis and osteoblastic differentiation in human osteoblast-like cells in vitro

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Abstract

Silicon deficiency in animals leads to bone defects. This element may therefore play an important role in bone metabolism. Silicon is absorbed from the diet as orthosilicic acid and concentrations in plasma are 5–20 μM. The in vitro effects of orthosilicic acid (0–50 μM) on collagen type 1 synthesis was investigated using the human osteosarcoma cell line (MG-63), primary osteoblast-like cells derived from human bone marrow stromal cells, and an immortalized human early osteoblastic cell line (HCC1). Collagen type 1 mRNA expression and prolyl hydroxylase activity were also determined in the MG-63 cells. Alkaline phosphatase and osteocalcin (osteoblastic differentiation) were assessed both at the protein and the mRNA level in MG-63 cells treated with orthosilicic acid. Collagen type 1 synthesis increased in all treated cells at orthosilicic acid concentrations of 10 and 20 μM, although the effects were more marked in the clonal cell lines (MG-63, HCCl 1.75- and 1.8-fold, respectively, $P < 0.001$, compared to 1.45-fold in the primary cell lines). Treatment at 50 μM resulted in a smaller increase in collagen type 1 synthesis (MG-63 1.45-fold, $P = 0.004$). The effect of orthosilicic acid was abolished in the presence of prolyl hydroxylase inhibitors. No change in collagen type 1 mRNA level was seen in treated MG-63 cells. Alkaline phosphatase activity and osteocalcin were significantly increased (1.5, 1.2-fold at concentrations of 10 and 20 μM, respectively, $P < 0.05$). Gene expression of alkaline phosphatase and osteocalcin also increased significantly following treatment. In conclusion, orthosilicic acid at physiological concentrations stimulates collagen type 1 synthesis in human osteoblast-like cells and enhances osteoblastic differentiation.