Time-varying magnetic fields increase cytosolic free Ca2+ in HL-60 cells

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Abstract

Electromagnetic fields have been reported to cause a variety of biological effects. It has been hypothesized that many of these phenomena are mediated by a primary effect on the concentration of cytosolic free calcium ([Ca2+]i). We investigated the effects of exposure to electromagnetic fields on [Ca2+]i in HL-60 cells using the Ca2(+)-sensitive fluorescent indicator indo-1. Indo-1-loaded cell samples were exposed to a radiofrequency electromagnetic field, a static magnetic field, and a time-varying magnetic field, which were generated by a magnetic resonance imaging (MRI) unit. We found that a 23-min exposure to all three fields, in combination, induced a significant increase in [Ca2+]i of 31 +/- 8 (SE) nM (P less than 0.01, n = 13) from a basal level of 121 +/- 8 nM. Also, cells exposed to only the time-varying magnetic field had a mean [Ca2+]i that was 34 +/- 10 nM (P less than 0.01, n = 11) higher than parallel control samples. Separate exposure to the radio-frequency (6.25 MHz) or static field (0.15 T) had no detectable effects. These results demonstrate that time-varying magnetic fields alter [Ca2+]i and suggest that at least some of the reported biological effects of time-varying magnetic fields may arise from elevation of [Ca2+]i.