Osteoporosis

Prevention of osteoporosis by pulsed electromagnetic fields.
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Using an animal model, we examined the use of pulsed electromagnetic fields, induced at a physiological frequency and intensity, to prevent the osteoporosis that is concomitant with disuse. By protecting the left ulnae of turkeys from functional loading, we noted a loss of bone of 13.0 per cent compared with the intact contralateral control ulnae over an eight-week experimental period. Using a treatment regimen of one hour per day of pulsed electromagnetic fields, we observed an osteogenic dose-response to induced electrical power, with a maximum osteogenic effect between 0.01 and 0.04 tesla per second. Pulse power levels of more or less than these levels were less effective. The maximum osteogenic response was obtained by a decrease in the level of intracortical remodeling, inhibition of endosteal resorption, and stimulation of both periosteal and endosteal new-bone formation. These data suggest that short daily periods of exposure to appropriate electromagnetic fields can beneficially influence the behavior of the cell populations that are responsible for bone-remodeling and that there is an effective window of induced electrical power in which bone mass can be controlled in the absence of mechanical loading.

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Pulsed electromagnetic fields prevent osteoporosis in an ovariectomized female rat model: a prostaglandin E2-associated process.

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With the use of Helmholtz coils and pulsed electromagnetic field (PEMF) stimulators to generate uniform time varying electromagnetic fields, the effects of extremely low frequency electromagnetic fields on osteoporosis and serum prostaglandin E(2) (PGE(2)) concentration were investigated in bilaterally ovariectomized rats. Thirty-five 3 month old female Sprague-Dawley rats were randomly divided into five different groups: intact (INT), ovariectomy (OVX), aspirin treated (ASP), PEMF stimulation (PEMF + OVX), and PEMF stimulation with aspirin (PEMF + ASP) groups. All rats were subjected to bilateral ovariectomy except those in INT group. Histomorphometric analyses showed
that PEMF stimulation augmented and restored proximal tibial metaphyseal trabecular bone mass (increased hard tissue percentage, bone volume percentage, and trabecular number) and architecture (increased trabecular perimeter, trabecular thickness, and decreased trabecular separation) in both PEMF + OVX and PEMF + ASP. Trabecular bone mass of PEMF + OVX rats after PEMF stimulation for 30 days was restored to levels of age matched INT rats. PEMF exposure also attenuated the higher serum PGE(2) concentrations of OVX rats and restored it to levels of INT rats. These experiments demonstrated that extremely low intensity, low frequency, single pulse electromagnetic fields significantly suppressed the trabecular bone loss and restored the trabecular bone structure in bilateral ovariectomized rats. We, therefore, conclude that PEMF may be useful in the prevention of osteoporosis resulting from ovariectomy and that PGE(2) might relate to these preventive effects. Copyright 2003 Wiley-Liss, Inc.


The effect of pulsed electromagnetic fields on osteoporosis at the knee in individuals with spinal cord injury.

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The purpose of this study was to determine the effects of pulsed electromagnetic fields on osteoporotic bone at the knee in individuals with chronic spinal injury. The study consisted of 6 males with complete spinal cord injury at a minimum of 2 years duration. Bone mineral density (BMD) was obtained at both knees at initiation, 3 months, 6 months, and 12 months using dual energy X-ray absorptiometry. In each case, 1 knee was stimulated using The Bone Growth Stimulator Model 3005 from American Medical Electronics, Incorporated and the opposite knee served as the control. Stimulation ceased at 6 months. At 3 months BMD increased in the stimulated knees 5.1% and declined in the control knees 6.6% (p < .05 and p < .02, respectively). By 6 months the BMD returned to near baseline values and at 12 months both knees had lost bone at a similar rate to 2.4% below baseline for the stimulated knee and 3.6% below baseline for the control. There were larger effects closer to the site of stimulation. While the stimulation appeared useful in retarding osteoporosis, the unexpected exaggerated decline in the control knees and reversal at 6 months suggests underlying mechanisms are more complex than originally anticipated. The authors believe a local as well as a systemic response was created.

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Modulation of bone loss during disuse by pulsed electromagnetic fields.

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The effect of pulsed electromagnetic fields (PEMFs) on bone loss associated with disuse was investigated by applying 1.5 Hz repetitions of 30 ms bursts of asymmetric pulses, varying from +2.5 to -135 mV, to bones deprived of their normal functional loading. The
proximal portion of one fibula in each of a group of ovariectomised adult female beagle dogs was isolated from functional loading in vivo by proximal and distal osteotomies. Comparison of these prepared bones with their intact contralateral controls after 12 weeks, showed a 23% reduction in cross-sectional area. In similarly prepared bones exposed to PEMFs for 1 h per day, 5 days per week, this bone loss was substantially and significantly reduced to 9% (p = 0.029). There was no evidence of any new bone formation on the periosteal surface of prepared fibulae in treated or untreated situations. PEMF treatment was not associated with any significant change in number of osteons per mm2 formed within the cortex of the bones, their radial closure rate, or their degree of closure. The modulation in loss of bone area associated with exposure to PEMFs can, therefore, be inferred to be due to a reduction in resorption on the bone surface.

J Bone Miner Res. 1990 May;5(5):437-42.

**Bone density changes in osteoporosis-prone women exposed to pulsed electromagnetic fields (PEMFs).**

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To determine the effect of a 72 Hz pulsating electromagnetic field (PEMF) on bone density of the radii of osteoporosis-prone women, the nondominant forearms of 20 subjects were exposed to PEMF 10 h daily for a period of 12 weeks. Bone density before, during, and after the exposure period was determined by use of a Norland-Cameron bone mineral analyzer. Bone mineral densities of the treated radii measured by single-photon densitometry increased significantly in the immediate area of the field during the exposure period and decreased during the following 36 weeks. A similar but weaker response occurred in the opposite arm, suggesting a "cross-talk" effect on the nontreated radii, from either possible arm proximity during sleep or very weak general field effects. The data suggest that properly applied PEMFs, if scaled for whole-body use, may have clinical application in the prevention and treatment of osteoporosis.


**Prevention of osteoporosis by pulsed electromagnetic fields.**

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Using an animal model, we examined the use of pulsed electromagnetic fields, induced at a physiological frequency and intensity, to prevent the osteoporosis that is concomitant with disuse. By protecting the left ulnae of turkeys from functional loading, we noted a
loss of bone of 13.0 per cent compared with the intact contralateral control ulnae over an eight-week experimental period. Using a treatment regimen of one hour per day of pulsed electromagnetic fields, we observed an osteogenic dose-response to induced electrical power, with a maximum osteogenic effect between 0.01 and 0.04 tesla per second. Pulse power levels of more or less than these levels were less effective. The maximum osteogenic response was obtained by a decrease in the level of intracortical remodeling, inhibition of endosteal resorption, and stimulation of both periosteal and endosteal new-bone formation. These data suggest that short daily periods of exposure to appropriate electromagnetic fields can beneficially influence the behavior of the cell populations that are responsible for bone-remodeling, and that there is an effective window of induced electrical power in which bone mass can be controlled in the absence of mechanical loading.


[Application of variable magnetic fields in medicine--15 years experience]

[Article in Polish]

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The results of 15-year own experimental and clinical research on application of variable magnetic fields in medicine were presented. In experimental studies analgesic effect (related to endogenous opioid system and nitrogen oxide activity) and regenerative effect of variable magnetic fields with therapeutical parameters was observed. The influence of this fields on enzymatic and hormonal activity, free oxygen radicals, carbohydrates, protein and lipid metabolism, dielectric and rheological properties of blood as well as behavioural reactions and activity of central dopamine receptor in experimental animals was proved. In clinical studies high therapeutic efficacy of magnetotherapy and magnetostimulation in the treatment of osteoarthrosis, abnormal ossification, osteoporosis, nasosinusitis, multiple sclerosis, Parkinson's disease, spastic paresis, diabetic polyneuropathy and retinopathy, vegetative neurosis, peptic ulcers, colon irritable and trophic ulcers was confirmed.