Treatment of Induced Osteoporosis Using Capacitively Coupled Electromagnetic Field Exposure.

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Abstract:

Pulsed electromagnetic fields (PEMFs) is a non-invasive treatment that works by permeating the body thereby reaching every cell and changing cell potentials and influencing the metabolic activity by stimulating paramagnetic ions. The body is an electrical device and every cell has a magnetic polarity which influences the transmittal of ions and on a greater scale influences such things such as calcification in bone formation, etc. PEMF of certain configuration have been shown to be equally effective clinically in promoting the healing of fracture nonunion and are believed to enhance calcification of extra cellular matrix. Speculation that bone growth and remodeling can be controlled by external stimulation has assumed an interesting dimension in recent years. The concept seems exciting, for it acts as forerunner to provide basic insight into the mechanism of charge transport and bone growth and that in any other biological tissue in general. Also, this has vast clinical potential. From a mechanical point of view bone subjected to any stress (internal or external), adjusts itself to the demands of the situation so as to neutralize the effect of the stimulus (negative feedback system). It is widely accepted that bone remodeling is dependent on load-induced voltages. In the present investigations a type of electrical stimulation is applied on induced osteoporotic rat bones. Pulsed electromagnetic field (PEMF's; carrier frequency, 14 MHz amplitude modulated at 16 Hz of amplitude 10 V peak to peak) is chosen to be capacitively coupled to the affected site.

For osteoporotic patients several prophylactic measures to prevent loss of bone are available. Although these regimens have been effective in the treatment of osteoporosis, limitations, cautions and dangers are inherent in their extended use. The clinical potential of treating osteoporosis by non-invasive means is therefore, substantial.

For laboratory investigations rats were subjected to sciatic neuroectomy and ovariectomy to induce osteoporosis and thereafter electrical stimulation given through capacitive coupling electrodes placed on one leg skin (noninvasive) and other kept as sham exposed. After exposure treatment treated, non-treated and controlled bones were examined by densitometric, histological, mineralogical and biochemical test. It is found that bone mineral density of treated bone significantly increased with respect to sham exposed bone, although it was not up to normal level. MRI T2 weighted images showed that exposed bones are darker than sham-exposed bones, which indicates higher bone density in treated bone. In SEM images compactness of cancellous bone and diaphysis cortical thickness are more in exposed bones. Bone mineral content of exposed bone was more than in sham-exposed bone. Calcium and Phosphorus content in bone ash is more in treated bone samples. On the basis of these results we can conclude that such an effective window of pulsed radio frequency fields may be used therapeutically for the treatment of human patients. The technique has no side effects and can be extrapolated to humans.