Low frequency and intensity PEMF therapy
Selected animal study research abstracts
At EMPpad Equine we are passionate about revolutionising equine healthcare. We believe in a proactive approach; providing our clients with a natural, long term and preventive equine health solution.
Sensitivity of calcium binding in cerebral tissue to weak environmental electric fields oscillating at low frequency.


Abstract

Weak sinusoidal electric fields modify the calcium efflux from freshly isolated chick and cat cerebral tissues bathed in Ringer's solution, at 36 degrees. Following incubation (30 min) with radioactive calcium (45Ca2+), each sample, immersed in fresh solution, was exposed for 20 min to fields at 1, 6, 16, 32, or 75 Hz, with electric gradients of 5, 10, 56, and 100 V/m in air. 45Ca2+ efflux in the solution was then measured in 0.2 ml aliquots and compared with efflux from unexposed control samples. Field exposures resulted in a general trend toward a reduction in the release of the preincubated 45Ca2+. Both frequency and amplitude sensitivities were observed. Maximum decreases occurred at 6 and 16 Hz (12-15%).

Biological effects of electromagnetic fields.


Abstract

Life on earth has evolved in a sea of natural electromagnetic (EM) fields. Over the past century, this natural environment has sharply changed with introduction of a vast and growing spectrum of man-made EM fields. From models based on equilibrium thermodynamics and thermal effects, these fields were initially considered too weak to interact with biomolecular systems, and thus incapable of influencing physiological functions. Laboratory studies have tested a spectrum of EM fields for bioeffects at cell and molecular levels, focusing on exposures at athermal levels. A clear emergent conclusion is that many observed interactions are not based on tissue heating. Modulation of cell surface chemical events by weak EM fields indicates a major amplification of initial weak triggers associated with binding of hormones, antibodies, and neurotransmitters to their specific binding sites. Calcium ions play a key role in this amplification. These studies support new concepts of communication between cells across the barriers of cell membranes; and point with increasing certainty to an essential physical organization in living matter, at a far finer level than the structural and functional image defined in the chemistry of molecules. New collaborations between physical and biological scientists define common goals, seeking solutions to the physical nature of matter through a strong focus on biological matter. The evidence indicates mediation by highly nonlinear, nonequilibrium processes at critical steps in signal coupling across cell membranes. There is increasing evidence that these events relate to quantum states and resonant responses in biomolecular systems, and not to equilibrium thermodynamics associated with thermal energy exchanges and tissue heating.

https://www.ncbi.nlm.nih.gov/m/pubmed/1064869/

https://www.ncbi.nlm.nih.gov/m/pubmed/8388394/
Pulsed electromagnetic fields accelerate functional recovery of transected sciatic nerve bridged by chitosan conduit: an animal model study.


Abstract

INTRODUCTION: Effect of whole body exposure to pulsed electromagnetic fields (PEMF) on nerve regeneration in a rat sciatic nerve transection model was assessed.

METHODS: Sixty male white Wistar rats were divided into four experimental groups (n = 15), randomly: In transected group (TC) left sciatic nerve was transected and stumps were fixed in adjacent muscle. In chitosan group (CHIT) the defect was bridged using a chitosan conduit filled with phosphate-buffered saline. In treatment group (CHIT/PEMF) the whole body was exposed to PEMF (0.3 mT, 2 Hz) for 4 h/day within 1-5 days. In normal control group (NC) sciatic nerve was only dissected and manipulated. Each group was subdivided into three subgroups of five animals each and nerve fibers were studied 4, 8 and 12 weeks after surgery.

RESULTS: Behavioral, functional, electrophysiological, biomechanical, gastrocnemius muscle mass findings and morphometric indices confirmed faster recovery of regenerated axons in CHIT/PEMF than in CHIT group (p < 0.05). Immunohistochemical reactions to S-100 in CHIT/PEMF were more positive than that in CHIT group.

DISCUSSION: Whole body exposure to PEMF improved functional recovery and morphometric indices of sciatic nerve. Detailed mechanism of neuroprotective action remains to be investigated.

CONCLUSION: PEMF combine with chitosan grafting could be considered as an effective, safe and tolerable treatment for peripheral nerve repair in clinical practice.

https://www.ncbi.nlm.nih.gov/m/pubmed/25448645/

Pulsed electromagnetic fields protect the balance between adipogenesis and osteogenesis on steroid-induced osteonecrosis of femoral head at the pre-collapse stage in rats.


Abstract

This study was designed to investigate the effects of pulsed electromagnetic fields (PEMF) on the balance of adipogenesis and osteogenesis on steroid-induced osteonecrosis of the femoral head (OFH) in rats. Forty-two rats were divided into three groups: Steroid group (S, n = 16); Steroid + PEMF group (S + P, n = 16); and Control group (C, n = 10). For groups S and S + P, all rats were first intravenously given 10 µg/kg lipopolysaccharide on day 1, and then intramuscularly injected with 20 mg/kg methylprednisolone acetate on days 2, 3, and 4, with an interval of 24 h. After 4 weeks, the S + P group was treated with PEMF (4.5-ms square pulse, repeated at 15 Hz, with a peak of 1.2 mT) for 4 h a day for the next 8 weeks. Group S was not exposed to PEMF.

Group C was chosen as the control group, without steroid use and exposure to PEMF. After 8 weeks of treatment, the histological changes, and mRNA and protein expressions of PPAR-γ2 and Runx2 were measured and analyzed. Compared with the S group, lower incidence of osteonecrosis (31% vs. 69%, P < 0.05) and empty osteocyte lacuna rate (36.16 ± 15.34 vs. 59.55 ± 21.70, P < 0.01) was observed in the S + P group. Furthermore, PEMF suppressed the expressions of PPAR-γ2 and improved the expressions of Runx2 in the femoral head (P < 0.05). All data suggest that PEMF is an effective physiotherapy in the treatment of steroid-induced ONFH, and the possible underlying mechanisms include protecting the balance between adipogenesis and osteogenesis.

https://www.ncbi.nlm.nih.gov/m/pubmed/24421074/
Pulsed electromagnetic fields improve bone microstructure and strength in ovariectomized rats through a Wnt/Lrp5/β-catenin signaling-associated mechanism.


Abstract
Growing evidence has demonstrated that pulsed electromagnetic field (PEMF), as an alternative noninvasive method, could promote remarkable in vivo and in vitro osteogenesis. However, the exact mechanism of PEMF on osteopenia/osteoporosis is still poorly understood, which further limits the extensive clinical application of PEMF. In the present study, the efficiency of PEMF on osteoporotic bone microarchitecture and bone quality together with its associated signaling pathway mechanisms was systematically investigated in ovariectomized (OVX) rats. Thirty rats were equally assigned to the Control, OVX and OVX+PEMF groups. The OVX+PEMF group was subjected to daily 8-hour PEMF exposure with 15 Hz, 2.4 mT (peak value). After 10 weeks, the OVX+PEMF group exhibited significantly improved bone mass and bone architecture, evidenced by increased BMD, Tb.N, Tb.Th and BV/TV, and suppressed Tb.Sp and SMI levels in the MicroCT analysis.

Three-point bending test suggests that PEMF attenuated the biomechanical strength deterioration of the OVX rat femora, evidenced by increased maximum load and elastic modulus. RT-PCR analysis demonstrated that PEMF exposure significantly promoted the overall gene expressions of Wnt1, LRP5 and β-catenin in the canonical Wnt signaling, but did not exhibit obvious impact on either RANKL or RANK gene expressions. Together, our present findings highlight that PEMF attenuated OVX-induced deterioration of bone microarchitecture and strength in rats by promoting the activation of Wnt/LRP5/β-catenin signaling rather than by inhibiting RANKL-RANK signaling. This study enriches our basic knowledge to the osteogenetic activity of PEMF, and may lead to more efficient and scientific clinical application of PEMF in inhibiting osteopenia/osteoporosis.

https://www.ncbi.nlm.nih.gov/m/pubmed/24244491/

Pulsed electromagnetic fields (PEMF) promote early wound healing and myofibroblast proliferation in diabetic rats.


Abstract
Reduced collagen deposition possibly leads to slow recovery of tensile strength in the healing process of diabetic cutaneous wounds. Myofibroblasts are transiently present during wound healing and play a key role in wound closure and collagen synthesis. Pulsed electromagnetic fields (PEMF) have been shown to enhance the tensile strength of diabetic wounds. In this study, we examined the effect of PEMF on wound closure and the presence of myofibroblasts in Sprague-Dawley rats after diabetic induction using streptozotocin. A full-thickness square-shaped dermal wound (2 cm × 2 cm) was excised aseptically on the shaved dorsum. The rats were randomly divided into PEMF-treated (5 mT, 25 Hz, 1 h daily) and control groups.

The results indicated that there were no significant differences between the groups in blood glucose level and body weight. However, PEMF treatment significantly enhanced wound closure (days 10 and 14 post-wounding) and re-epithelialization (day 10 post-wounding), although these improvements were no longer observed at later stages of the wound healing process. Using immunohistochemistry against α-smooth muscle actin (α-SMA), we demonstrated that significantly more myofibroblasts were detected on days 7 and 10 post-wounding in the PEMF group when compared to the control group. We hypothesized that PEMF would increase the myofibroblast population, contributing to wound closure during diabetic wound healing.

https://www.ncbi.nlm.nih.gov/m/pubmed/24395219/
Pulsed electromagnetic fields accelerate wound healing in the skin of diabetic rats.


Abstract

Delayed wound healing is a common complication in diabetes mellitus. From this point of view, the main purpose of the present study is to investigate the effect of extremely low frequency pulsed electromagnetic fields (ELF PEMFs) on skin wound healing in diabetic rats. In this study, diabetes was induced in male Wistar rats via a single subcutaneous injection of 65 mg/kg streptozocin (freshly dissolved in sterile saline, 0.9%). One month after the induction of diabetes, a full-thickness dermal incision (35 mm length) was made on the right side of the paravertebral region. The wound was exposed to ELF PEMF (20 Hz, 4 ms, 8 mT) for 1 h per day. Wound healing was evaluated by measuring surface area, percentage of healing, duration of healing, and wound tensile strength. Obtained results showed that the duration of wound healing in diabetic rats in comparison with the control group was significantly increased. In contrast, the rate of healing in diabetic rats receiving PEMF was significantly greater than in the diabetic control group. The wound tensile strength also was significantly greater than the control animals. In addition, the duration of wound healing in the control group receiving PEMF was less than the sham group. Based on the above-mentioned results we concluded that this study provides some evidence to support the use of ELF PEMFs to accelerate diabetic wound healing. Further research is needed to determine the PEMF mechanisms in acceleration of wound healing in diabetic rats.

https://www.ncbi.nlm.nih.gov/m/pubmed/20082338/

Therapeutic effects of 15 Hz pulsed electromagnetic field on diabetic peripheral neuropathy in streptozotocin-treated rats.


Abstract

Although numerous clinical studies have reported that pulsed electromagnetic fields (PEMF) have a neuroprotective role in patients with diabetic peripheral neuropathy (DPN), the application of PEMF for clinic is still controversial. The present study was designed to investigate whether PEMF has therapeutic potential in relieving peripheral neuropathic symptoms in streptozotocin (STZ)-induced diabetic rats. Adult male Sprague-Dawley rats were randomly divided into three weight-matched groups (eight in each group): the non-diabetic control group (Control), diabetes mellitus with 15 Hz PEMF exposure group (DM+PEMF) which were subjected to daily 8-h PEMF exposure for 7 weeks and diabetes mellitus with sham PEMF exposure group (DM). Signs and symptoms of DPN in STZ-treated rats were investigated by using behavioral assays. Meanwhile, ultrastructural examination and immunohistochemical study for vascular endothelial growth factor (VEGF) of sciatic nerve were also performed. During a 7-week experimental observation, we found that PEMF stimulation did not alter hyperglycemia and weight loss in STZ-treated rats with DPN. However, PEMF stimulation attenuated the development of the abnormalities observed in STZ-treated rats with DPN, which were demonstrated by increased hind paw withdrawal threshold to mechanical and thermal stimuli, slighter demyelination and axon enlargement and less VEGF immunostaining of sciatic nerve compared to those of the DM group. The current study demonstrates that treatment with PEMF might prevent the development of abnormalities observed in animal models for DPN. It is suggested that PEMF might have direct corrective effects on injured nerves and would be a potentially promising non-invasive therapeutic tool for the treatment of DPN.

https://www.ncbi.nlm.nih.gov/m/pubmed/23637830/
Low frequency and low intensity pulsed electromagnetic field exerts its antiinflammatory effect through restoration of plasma membrane calcium ATPase activity.


Abstract

Rheumatoid arthritis (RA) is a chronic inflammatory disorder affecting 1% of the population worldwide. Pulsed electromagnetic field (PEMF) has a number of well-documented physiological effects on cells and tissues including antiinflammatory effect. This study aims to explore the antiinflammatory effect of PEMF and its possible mechanism of action in amelioration of adjuvant induced arthritis (AIA). Arthritis was induced by a single intradermal injection of heat killed Mycobacterium tuberculosis at a concentration of 500 microg in 0.1 ml of paraffin oil into the right hind paw of rats. The arthritic animals showed a biphasic response regarding changes in the paw edema volume. During the chronic phase of the disease, arthritic animals showed an elevated level of lipid peroxides and depletion of antioxidant enzymes with significant radiological and histological changes.

Besides, plasma membrane Ca(2+) ATPase (PMCA) activity was inhibited while intracellular Ca(2+) level as well as prostaglandin E(2) levels was noticed to be elevated in blood lymphocytes of arthritic rats. Exposure of arthritic rats to PEMF at 5 Htzx4 microT x 90 min, produced significant antiexudative effect resulting in the restoration of the altered parameters. The antiinflammatory effect could be partially mediated through the stabilizing action of PEMF on membranes as reflected by the restoration of PMCA and intracellular Ca(2+) levels in blood lymphocytes subsequently inhibiting PGE(2) biosynthesis. The results of this study indicated that PEMF could be developed as a potential therapy for RA in human beings.

https://www.ncbi.nlm.nih.gov/m/pubmed/17537462/

Optimization of pulsed electromagnetic field therapy for management of arthritis in rats.


Abstract

Studies were undertaken to find out the effects of low frequency pulsed electromagnetic field (PEMF) in adjuvant induced arthritis (AIA) in rats, a widely used model for screening potential therapies for rheumatoid arthritis (RA). AIA was induced by an intradermal injection of a suspension of heat killed Mycobacterium tuberculosis (500 mug/0.1 ml) into the right hind paw of male Wistar rats. This resulted in swelling, loss of body weight, increase in paw volume as well as the activity of lysosomal enzymes viz., acid phosphatase, cathepsin D, and beta-glucuronidase and significant radiological and histological changes. PEMF therapy for arthritis involved optimization of three significant factors, viz., frequency, intensity, and duration; and the waveform used is sinusoidal.

The use of factorial design in lieu of conventional method resulted in the development of an ideal combination of these factors. PEMF was applied using a Fransleau-Braunbeck coil system. A magnetic field of 5 Hz x 4 muT x 90 min was found to be optimal in lowering the paw edema volume and decreasing the activity of lysosomal enzymes. Soft tissue swelling was shown to be reduced as evidenced by radiology. Histological studies confirmed reduction in inflammatory cells infiltration, hyperplasia, and hypertrophy of cells lining synovial membrane. PEMF was also shown to have a membrane stabilizing action by significantly inhibiting the rate of release of beta-glucuronidase from lysosomal rich and sub-cellular fractions. The results indicated that PEMF could be developed as a potential therapy in the treatment of arthritis in humans.

https://www.ncbi.nlm.nih.gov/m/pubmed/15887257/
Pulsed electromagnetic field improves cardiac function in response to myocardial infarction.


Abstract

Extracorporeal pulsed electromagnetic field (PEMF) has been shown the ability to improve regeneration in various ischemic episodes. Here, we examined whether PEMF therapy facilitate cardiac recovery in rat myocardial infarction (MI), and the cellular/molecular mechanisms underlying PEMF-related therapy was further investigated. The MI rats were exposed to active PEMF for 4 cycles per day (8 minutes/cycle, 30 ± 3 Hz, 5 mT) after MI induction. The data demonstrated that PEMF treatment significantly inhibited cardiac apoptosis and improved cardiac systolic function. Moreover, PEMF treatment increased capillary density, the levels of vascular endothelial growth factor (VEGF) and hypoxic inducible factor-1α in infarct border zone.

Furthermore, the number and function of circulating endothelial progenitor cells were advanced in PEMF treating rats. In vitro, PEMF induced the degree of human umbilical venous endothelial cells tubulization and increased soluble pro-angiogenic factor secretion (VEGF and nitric oxide).

In conclusion, PEMF therapy preserves cardiac systolic function, inhibits apoptosis and trigger postnatal neovascularization in ischemic myocardium.


Notes:
The EMPpad Equine system uses curtain based applicators to deliver world leading low frequency and intensity PEMF therapy to the horse in a time efficient and stress-free way. It is completely unique and is a revolution in equine healthcare.
The new curtain applicators have been specially designed with a wire mesh core within, which allows the curtain to be both lightweight and flexible. A water resistant and easy wipe clean material has been used and the curtains have a series of ring eyelets along the top for simple and quick suspension in a stable or out in the yard. The curtain applicators are used for a whole body treatment as they are big enough to cover the whole horse rather than using a blanket applicator that can only cover the shoulder, barrel and flank areas.

Using advanced PEMF technology, the EMPpad Equine is controlled by a new control unit and newly designed curtain and leg applicators. These have been developed to reduce stress to the horse as much as possible while still maintaining the high quality PEMF that is expected from all EMPpad products.

Based on the existing advanced control unit for the iMRS 2000, special software has been developed to specifically operate the newly designed curtain and leg applicators of the EMPpad Equine. This software is held on an SD card which is inserted into the control unit to enable it to generate PEMF programs suitable for the horse.

To provide a practical, gentle and stress free treatment for the horse, the newly developed curtain applicators do not have to come into contact anymore. The horse just needs to stand in between the two curtain applicators which are suspended between 3-5 metres apart to receive the PEMF treatment. All this with minimal stress and fuss to both the owner and horse.

The leg applicators are designed with the same high quality water resistant and easy wipe material and are used to treat specific injury sites on the legs. These applicators can be used on either the front or rear legs and produce a more intense electro-magnetic pulse to stimulate greater healing in the tissue around the applicators. This aids a quicker return to activity for the horse if they suffer from any leg injuries or damage.

Included:

The EMPpad Equine Complete comes with the control unit, mains plug, 2 curtain applicators, 2 leg applicators and the specific Equine software SD card.
“Bobby, 22 year old riding school horse. Bobby was losing weight, intermittently lame, had summer off. Came back into yard in November and has been standing in the [EMPpad Equine] curtains almost twice daily for 5 weeks. Is now back in use in the Riding School, no lameness and is gaining weight and much happier in himself.”

Kathryn Reeve
St Leonards Equitation Centre, Launceston