Scientific Articles and Abstracts

A wealth of articles on Pulsing Electromagnetic Field therapy (PEMF) technology is available. Following is a selection of abstracts, articles and references on PEMF. This information has been collected to indicate the benefits on the use of pulsing electromagnetic field therapy and many are double blind, placebo controlled studies.

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The Effect of Pulsed Electromagnetic Fields in the Treatment of Osteoarthritis of the Knee and Cervical Spine. Report of Randomized, Double-Blind, Placebo Controlled Trials

OBJECTIVE. We conducted a randomized, double blind clinical trial to determine the effectiveness of pulsed electromagnetic fields (PEMF) in the treatment of osteoarthritis (OA) of the knee and cervical spine. METHODS. A controlled trial of 18 half-hour active or placebo treatments was conducted in 86 patients with OA of the knee and 81 patients with OA of the cervical spine, in which pain was evaluated using a 10 cm visual analog scale, activities of daily living using a series of questions (answered by the patient as never, sometimes, most of the time, or always), pain on passive motion (recorded as none, slight, moderate, or severe), and joint tenderness (recorded using a modified Ritchie scale). Global evaluations of improvement were made by the patient and examining physician. Evaluations were made at baseline, midway, end of treatment, and one month after completion of treatment.

RESULTS. Matched pair t tests showed extremely significant changes from baseline for the treated patients in both knee and cervical spine studies at the end of treatment and the one month follow-up observations, whereas the changes in the placebo patients showed lesser degrees of significance at the end of treatment, and had lost significance for most variables at the one month follow-up. Means of the treated group of patients with OA of the knee showed greater improvement from baseline values than the placebo group by the end of treatment and at the one month follow-up observation. Using the 2-tailed t test, at the end of treatment the differences in the means of the 2 groups reached statistical significance for pain, pain on motion, and both the patient overall assessment and the physician global assessment. The means of the treated patients with OA of the cervical spine showed greater improvement from baseline than the placebo group for most variables at the end of treatment and one month follow-up observations; these differences reached statistical significance at one or more observation points for pain, pain on motion, and tenderness.
CONCLUSION. PEMF has therapeutic benefit in painful OA of the knee or cervical spine.

Trock D. et.al. Department of Medicine, Danbury Hospital, CT. J. of Rheumatology

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Low-amplitude, extremely low frequency magnetic fields for the treatment of osteoarthritic knees: a double-blind clinical study.

CONTEXT: Non-invasive magneto-therapeutic approaches to bone healing have been successful in past clinical studies. OBJECTIVE: To determine the effectiveness of low-amplitude, extremely low frequency magnetic fields on patients with knee pain due to osteoarthritis. DESIGN: Placebo-controlled, randomized, double-blind clinical study. SETTING: 4 outpatient clinics. PARTICIPANTS: 176 patients were randomly assigned to 1 of 2 groups, the placebo group (magnet off) or the active group (magnet on). INTERVENTION: 6-minute exposure to each magnetic field signal using 8 exposure sessions for each treatment session, the number of treatment sessions totalling 8 during a 2-week period, yielded patients being exposed to uniform magnetic fields for 48 minutes per treatment session 8 times in 2 weeks. The magnetic fields used in this study were generated by a resonator, which consists of two 18-inch diameter (46-cm diameter) coils connected in series, in turn connected to a function generator via an attenuator to obtain the specific amplitude and frequency. The range of magnetic field amplitudes used was from 2.74 x 10(-7) to 3.4 x 10(-8) G, with corresponding frequencies of 7.7 to 0.976 Hz. OUTCOME MEASURES: Each subject rated his or her pain level from 1 (minimal) to 10 (maximal) before and after each treatment and 2 weeks after treatment. Subjects also recorded their pain intensity in a diary while outside the treatment environment for 2 weeks after the last treatment session (session 8) twice daily: upon awakening (within 15 minutes) and upon retiring (just before going to bed at night). RESULTS: Reduction in pain after a treatment session was significantly ($P < .001$) greater in the magnet-on group (46%) compared to the magnet-off group (8%). CONCLUSION: Low-amplitude, extremely low frequency magnetic fields are safe and effective for treating patients with chronic knee pain due to osteoarthritis.

Jacobson J. et.al. Inst. for Biophysical Research, Jupiter, FL, USA

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Pulsed Electromagnetic Field Therapy, PEMT. How does it work?

All living cells within the body possess potentials between the inner and outer membrane of the cell, which, under normal healthy

circumstances, are fixed. Different cells, e.g. Muscle cells and Nerve cells, have different potentials of about -70 mV respectively. When cells are damaged, these potentials change such that the balance across the membrane changes, causing the attraction of positive sodium ions into the cell and negative trace elements and proteins out of the cell. The net result is that liquid is attracted into the interstitial area and swelling or oedema ensues. The application of pulsed magnetic fields has, through research findings, been shown to help the body to restore normal potentials at an accelerated rate, thus aiding the healing of most wounds and reducing swelling faster. The most effective frequencies found by researchers so far, are very low frequency pulses of a 50Hz base. These, if gradually increased to 25 pulses per second for time periods of 600 seconds (10 minutes), condition the damaged tissue to aid the natural healing process.

Pain reduction is another area in which pulsed electromagnetic therapy has been shown to be very effective. Pain signals are transmitted along nerve cells to pre-synaptic terminals. At these terminals, channels in the cell alter due to a movement of ions. The membrane potential changes, causing the release of a chemical transmitter from a synaptic vesicle contained within the membrane. The pain signal is chemically transferred across the synaptic gap to chemical receptors on the post-synaptic nerve cell. This all happens in about 1/2000th of a second, as the synaptic gap is only 20 to 50 nm wide. As the pain signal, in chemical form, approaches the post-synaptic cell, the membrane changes and the signal is transferred. If we look at the voltages across the synaptic membrane then, under no pain conditions, the level is about -70 mV. When the pain signal approaches, the membrane potential increases to approximately +30 mV, allowing a sodium flow. This in turn triggers the synaptic vesicle to release the chemical transmitter and so transfer the pain signal across the synaptic gap or cleft. After the transmission, the voltage reduces back to its normal quiescent level until the next pain signal arrives.

The application of pulsed magnetism to painful sites causes the membrane to be lowered to a hyper-polarization level of about -90 mV. When a pain signal is detected, the voltage must now be raised to a relatively higher level in order to fire the synaptic vesicles. Since the average change of potential required to reach the trigger voltage of nearly +30 mV is +100 mV, the required change is too great and only +10 mV is attained. This voltage is generally too low to cause the synaptic vesicle to release the chemical transmitter and hence the pain signal is blocked. The most effective frequencies that have been observed from research in order to cause the above changes to membrane potentials, are a base frequency of around 100Hz and pulse rate settings of between 5 and 25Hz.

Lecture abstract Dr. D. Laycock, Ph.D. Med. Eng. MBES, MIPEM, B.Ed.

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Magnetic pulse treatment for knee osteoarthritis: a randomised, double-blind, placebo-controlled study.

We assessed the efficacy and tolerability of low-frequency pulsed electromagnetic fields (PEMF) therapy in patients with clinically symptomatic knee osteoarthritis (OA) in a randomised, placebo-controlled, double-blind study of six weeks' duration. While the treated group demonstrated improvement over different indices to the contrary, the control group demonstrated none. There were no clinically relevant adverse effects attributable to active treatment. These results suggest that the unipolar magnetic devices are beneficial in reducing pain and disability in patients with knee OA resistant to conventional treatment in the absence of significant side effects.

Pipitone N. et.al. Rheumatology Department, King's College Hospital (Dulwich), London, UK.

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Electrochemical therapy of pelvic pain: effects of pulsed electromagnetic fields (PEMF) on tissue trauma.

Unusually effective and long-lasting relief of pelvic pain of gynaecological origin has been obtained consistently by short exposures of affected areas to the application of a magnetic induction device. Treatments are short, fasting-acting, economical and in many instances have obviated surgery. This report describes typical cases such as dysmenorrhoea, endometriosis, ruptured ovarian cyst, acute lower urinary tract infection, post-operative haematoma, and persistent dyspareunia in which pulsed magnetic field treatment has not, in most cases, been supplemented by analgesic medication. Of 17 female patients presenting with a total of 20 episodes of pelvic pain, 16 patients representing 18 episodes (90%) experienced marked, even dramatic relief, while two patients representing two episodes reported less than complete pain.

Jorgensen W. et.al. International Pain Research Institute, Los Angeles, California.

Evaluation of electromagnetic fields in the treatment of pain in patients with lumbar radiculopathy or whiplash syndrome.

Back pain and whiplash syndrome are very common diseases involving tremendous costs and extensive medical effort. A quick and effective reduction of symptoms, especially pain, is required. In two prospective randomized studies, patients with either lumbar radiculopathy in the segments L5/S1 or whiplash syndrome were investigated. Electromagnetic devices are pulsed field (PEMF) and constant wave (CW) types. These studies indicate both are effective, PEMF usually more quickly than CW. Pulsed magnetic fields appear to have a considerable and statistically significant potential for reducing pain in cases of lumbar radiculopathy and whiplash syndrome.

Thuile Ch. et.al. International Society of Energy Medicine, Vienna, Austria.

We assessed the efficacy and tolerability of low-frequency pulsed electromagnetic fields (PEMF) therapy in patients with clinically symptomatic knee osteoarthritis (OA) in a randomised, placebo-controlled, double-blind study of six weeks' duration.

Patients with radiographic evidence and symptoms of OA (incompletely relieved by conventional treatments), according to the criteria of the American College of Rheumatology, were recruited from a single tertiary referral centre. 75 Patients fulfilling the above criteria were randomised to receive active PEMF treatment by unipolar magnetic devices or placebo. Six patients failed to attend after the screening and were excluded from analysis. The primary outcome measure was reduction in overall pain assessed on a four-point Likert scale ranging from nil to severe. Secondary outcome measures included the WOMAC Osteoarthritis Index (Likert scale) and the EuroQol (Euro-Quality of Life, EQ-5D). Baseline assessments showed that the treatment groups were equally matched. Although there were no significant differences between active and sham treatment groups in respect of any outcome measure after treatment, paired analysis of the follow-up observations on each patient showed significant improvements in the actively treated group in the WOMAC global score ($p = 0.018$), WOMAC pain score ($p = 0.065$), WOMAC disability score ($p = 0.019$) and EuroQol score ($p = 0.001$) at study end compared to baseline. In contrast, there were no improvements in any variable in the placebo-treated group. There were no clinically relevant adverse effects attributable to active treatment. These results suggest that PEMF magnetic devices are beneficial in reducing pain and disability in patients with knee OA resistant to conventional treatment in the absence of significant side-effects.

Further studies using different types of magnetic devices, treatment protocols and patient populations are warranted to confirm the general efficacy of PEMF therapy in OA and other conditions.

Nicolò Pipitone, David L. Scott

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Pulsed magnetic field therapy and the physiotherapist

The therapeutic effect of the application of pulsed magnetic field therapy (PMFT) has at last received world-wide recognition, although for a long time many practitioners saw it only as an aid to fracture union. Research has now shown that it has the potential to improve a wide range of conditions, although few understood just how it achieved its effectiveness. Extensive research has since been carried out to determine the mechanism by which this occurs. For the physiotherapist, presented with a wide range of clinical problems, PMFT is an invaluable aid to the clinic.

Resolution of soft tissue injuries:

Over the past few years, research has shown that its effectiveness is not through heat production - as is the case with some modern treatments - but is at the cellular level. One significant outcome of this is the effect it has on soft tissue injuries. As early as 1940 it was suggested that magnetic fields might influence membrane permeability. It has since been established that magnetic fields can influence ATP (Adenosine Tri-phosphate) production; increase the supply of oxygen and nutrients via the vascular system; improve the removal of waste via the lymphatic system; and help to re-balance the distribution of ions across the cell membrane. Healthy cells in tissue have a membrane potential difference between the inner and outer membrane. This causes a steady flow of ions through its pores. In a damaged cell the potential is raised and an increased and an increased sodium inflow occurs. As a result, interstitial fluid is attracted to the area, resulting in swelling and oedema.

The application of PMFT to damaged cells accelerates the re-establishment of normal potentials (Sansaverino) increasing the rate of healing and reducing swelling. This can help to disperse bruising also. A magnetic field pulsed at 5Hz with a base frequency of 50Hz can have the same effect as an ice pack in that in that it causes vasoconstriction.

Effects on fracture repair:

Acceptance of magnetic fields in medicine came about foremost in the field of orthopedics. Low frequency and low intensity fields have been used extensively for the treatment of non-union fractures. By 1979 this method was approved in the USA as a safe and effective treatment for non-union fractures; for failed arthroses; and for congenital pseudo-arthroses. According to Bassett this method has been used by more than 6,000 surgeons. The success rate was over 80% for tibial lesions. No patient suffered complications and biological side-effects included improved healing and increased neural function. In-depth research carried out to investigate this, shows that magnetic fields influence the process of bone formation in the intercellular medium. Madronero showed that bone healing was promoted by means of the influence of the magnetic field on the crystal formation of calcium salts.

Pain reduction:

Pulsed magnetic field therapy has been shown to bring about a reduction of pain, which again is due to action at the cellular level. Pain is transmitted as an electric signal, which encounters gaps at intervals along its path. The signal is transferred in the form of a chemical signal across the synaptic gap and this is detected by receptors on the post-synaptic membrane. A charge of about -70mV exists across the inner and outer membranes, but when a pain signal arrives it raises this to +30mV. This action causes channels to open in the membrane,

triggering the release of a chemical transmitter and allowing ions to flow into the synaptic gap. The cell then re-polarizes to its previous resting level. Research by Warnke suggests that PMFT affects the quiescent potential of the membrane, lowering it to a hyper-polarized level of -90mV. Transmission is effectively blocked since the pain signal is unable to raise the potential to the level required to trigger the release of the chemical transmitter. Again, the frequency of the applied magnetic field is important, as the most effective frequency to produce this effect was found to be a base frequency of 100Hz pulsed at between 5 and 25 pulses per second.

Clinical applications:

The value of pulsed magnetic field therapy has been shown to cover a wide range of conditions, with well documented trials carried out by hospitals, rheumatologists and physiotherapists. For example, the department of rheumatology at Addenbrookes Hospital carried out investigations into the use of PMFT for the treatment of persistent rotator cuff tendinitis. The treatment was applied to patients who had symptoms refractory to steroid injection and other conventional treatments. At the end of the trial, 65% of these were symptom free, with 18% of the remainder being greatly improved.

Lau (School of Medicine, Loma University, USA) reported on the application of PMFT to the problems of diabetic retinopathy. Patients were treated over a 6-week period, 76% of the patients had a reduction in the level of numbness and tingling. All patients had a reduction of pain, with 66% reporting that they were totally pain-free. Many research studies, including Lau, reported on the application of PMFT for conditions such as sports injuries and for patients with joint and spinal problems. Although these are too numerous to mention individually, in almost every instance there was a reduction, if not complete resolution of symptoms. Soft tissue injuries and joint pains tended to be resolved within 5 days of treatment. Patients with cervical problems and low back pain were also successfully treated, whereas previous treatment with ice, traction and other therapies had been unsuccessful. In yet another trial, the effect of applying PMFT to sufferers of Multiple Sclerosis was investigated (Geseo) 70% of sufferers had a reduction of weakness, pain and spasticity, with 50% reporting improvement of their bladder incontinence. Through the evaluation of hundreds of research papers, a number of points have been established regarding PMFT: The field must be pulsed, with low frequency to achieve the best effect. Different conditions require different frequencies. For example, 5Hz causes vasoconstriction whilst 10Hz and above causes vasodilatation. Biological effectiveness is achieved in just 10 minutes for most injuries, so that long treatment sessions are not required. When used at the correct level there are no recorded side effects. Although PMFT is not yet recommended for use during pregnancy or in the presence of tumors, there are papers to suggest that magnetic fields can inhibit the growth of tumors.

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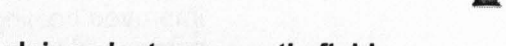

Treatment of migraine with pulsing electromagnetic fields: a double-blind, placebo-controlled study.

The effect of exposure to pulsing electromagnetic fields on migraine activity was evaluated by having 42 subjects (34 women and 8 men), who met the International Headache Society's criteria for migraine, participate in a double-blind, placebo-controlled study. During the first month of follow-up, 73% of those receiving actual exposure, reported decreased headaches (45% substantial decrease, 14% excellent decrease) compared to half of those receiving the placebo (15% worse, 20% good, 0% excellent). Ten of the 22 subjects who had actual exposure received 2 additional weeks of actual exposure, after their initial 1-month follow-up. All showed decreased headache activity (50%

substantial, 38% excellent). Eight of the subjects in the placebo group elected to receive 2 weeks of actual exposure after the initial 1-month follow-up with 75% showing decreased headache activity (38% substantial, 38% excellent). In conclusion, exposure to pulsing electromagnetic fields for at least 3 weeks is an effective, short-term intervention for migraine.

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