How Pulsed Electro Magnetic Therapy Works

A series if medical research papers and documents researched and compiled by:

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Recent Clinical Studies.

Pulsed Electro Magnetic Therapy is also referred too as Pulsed Electro Magnetic Field Therapy (PEMF), Magnetotherapy. Or sometimes Pulsed magnetic field therapy (PMFT), and is defined as a treatment for fractures as the application of time- varying magnetic fields that induce voltage wave-form patterns in bone and similar tissues. The electrical voltage is induced at right angles to the pulsed, or dynamic, magnetic field. The strength of the magnetic field in clinical field in comparison is in the region of 0.5G – and a frequency range of 1Hz to about 200Hz is typically used. All the studies quoted in this section of the article are regarding pulsed magnetic fields and NOT static magnetic fields. Although there is a wealth of firms peddling static magnetic therapy, the research evidence did not merit its inclusion in this article. The strength of a magnetic field is measured in Tesla's. There are 10,000 Gauss units to one Tesla. The FDA in America approved the use of PMFT in the treatment of fractures and non- union fractures in 1979

Nelson et al 25 demonstrated that application of PMFT caused up-regulation of messenger RNA (mRNA) along with protein synthesis of TGFβ and BMP gene group, all of which have been shown to enhance fracture repair. They concluded that PMFT is indicated in established non-unions, failed arthrodeses and congenital pseudarthrosis. Ryaby et al 29 showed that PMFT causes differentiation of osteogenic precursor cells along with up-regulation of TGFβ, BMPs and IGF. Gossling et al 30 in a literature review in 1992 concluded that PMFT was at least as effective as surgery in cases of non-union with an overall success rate of 81% against 82% for surgery, although infected non- unions showed a success rate of 81% against 69%. Mooney 31 in 1990, in a study of the efficacy of PMFT in lumbar inter-body fusions showed a success rate of 92% in the PMFT group compared to 64.9% in the placebo group. In the same study, previously failed fusions showed a 67% fusion rate after 90 days of PMFT.

A similar study by Marks 32 in 2000, also regarding lumbar inter-body fusions, showed a fusion rate of 97.6% in the PMFT group compared to 52.6% in the controls ($p=<0.001$) Bassett et al 35 in 1982 researched results in treating un-united fractures and failed arthrodeses with PMFT. In a group of patients with an average of 4.7 years non-union, 3.4 previous surgical failures and a 35% infection rate, bony healing took place in 75% of the patients. In the same study, overall success in healing non-unions was recorded as 81% at the Columbia – Presbyterian Med. Centre, 79% internationally and 76% in other patients in the USA. After failed arthrodeses following failed total knee prosthesis, PMFT produced

healing in 85% of the patients and of the 15% unsuccessful, further surgery combined with PMFT was effective in all cases. In 1994 Hart 36 did a study on induced current in bone in relation to PMFT. He demonstrated that the variation in the conductivity of the fracture gap during healing caused the induced current density pattern to change accordingly, whereas the induced electrical field remained relatively unchanged.

The effects observed in bone in studies involving fracture non-unions and failed arthrodeses have included angiogenesis, increased mineralization and increase in endochondral – intra-cartilagenous – ossification. Increase in osteoblastic activity and decrease in osteoplastic activity have been observed, along with the all-important angiogenesis, in studies on spinal fusions and osteonecrosis. Bassett38 in 1993 demonstrated the effectiveness of PMFT. In a prospective, double-blind trial of fracture non-unions there was a 75%-95% success rate, in a prospective study of failed arthrodeses a success rate of 85%-90%, in a prospective study of spinal fusions a 90%-95% success rate, in a prospective, double-blind trial of congenital pseudarthrosis a 70%-80% success rate and in a prospective study of osteonecrosis of the hip a 80%-100% rate of success.

Many benefits of Pulsed Electro-Magnetic Field (“PEMF”) therapy have been demonstrated through more than 2,000 University level double blind medical studies done in many countries with many different PEMF therapy devices. Some of the positive effects of PEMF therapy were well established by the mid 1900’s. The first commercially produced low power PEMF devices entered the market in the ear1y 1900s. These were used for studies and experimentation in healing and cellular wellness. They were sold to both consumers and as medical devices to doctors. The first commercially produced high power PEMF devices entered the market around 1975. They focused on muscle, nerve, tendon, ligament and cartilage health, on reducing pain and on regeneration. Medical PEMF therapy has been accepted in many countries around the wor1d. The US FDA accepted the use of PEMF devices in the healing of non-union bone fractures in 1979, urinary incontinence and muscle stimulation in 1998, and depression and anxiety in 2006. Israel has accepted the use of PEMF devices in for migraine headaches. Canada has accepted PEMF devices for several uses. The European Union has many acceptances for the use of PEMF therapy in many areas including healing and recovery from trauma, degeneration and the treatment of the pain associated with these conditions.

Differences in PEMF Therapy Devices

- **Power Level** The magnetic energy produced by the various PEMF devices can be as little as that of the Earth's magnetic field to more than 10,000 times as powerful. The lower power devices are generally used for cellular health and bone healing. The higher power devices are generally used for recovery of trauma from accidents, sports injuries and surgery, as well as for control and improvement of degenerative diseases. Both low power and high power devices help reduce pain, but the higher power devices are more effective in doing so.
- **Continuous or Pulsed medical Waveform** Although there are exceptions in both types, most low power PEMF devices have a continuous waveform while most high power PEMF devices have a pulsed waveform.
- **Shape of Waveform** The continuous waveform PEMF devices can produce a square, a saw tooth or a sine wave. The pulsed output PEMF devices usually produce a biphasic sine wave.
- **Control of Frequency** Many low power PEMF devices have pre-set frequencies to choose from according to the manufacturers' own different theories. Most high power PEMF devices have a user variable control of the frequency.
- **Duration of Treatment** Depending on the power level of the PEMF device, the treatment duration can be from three minutes to hours. Primary Benefits of High Power PEMF Clinical evidence shows that PEMF therapy reduces pain associated 'with trauma from accidents, sports injuries, surgeries and bums as well as from disease and degeneration

PEMF therapy improves these conditions in many different ways that include mechanical, electrical, chemical, and magnetic processes within the cells of the body. In 1995, Siskin and Walker provided a summary of clinical results on soft tissue damage. They observed no adverse effects and the following positive effects were reported:

- Decreased pain
- Reduced inflammation
- Increased range of motion
- Faster functional recovery
- Reduced muscle loss after surgery

- Increased tensile strength in ligaments
- Faster healing of skin wounds
- Enhanced capillary connation
- Acceleration of nerve regeneration
- And decreased tissue necrosis.

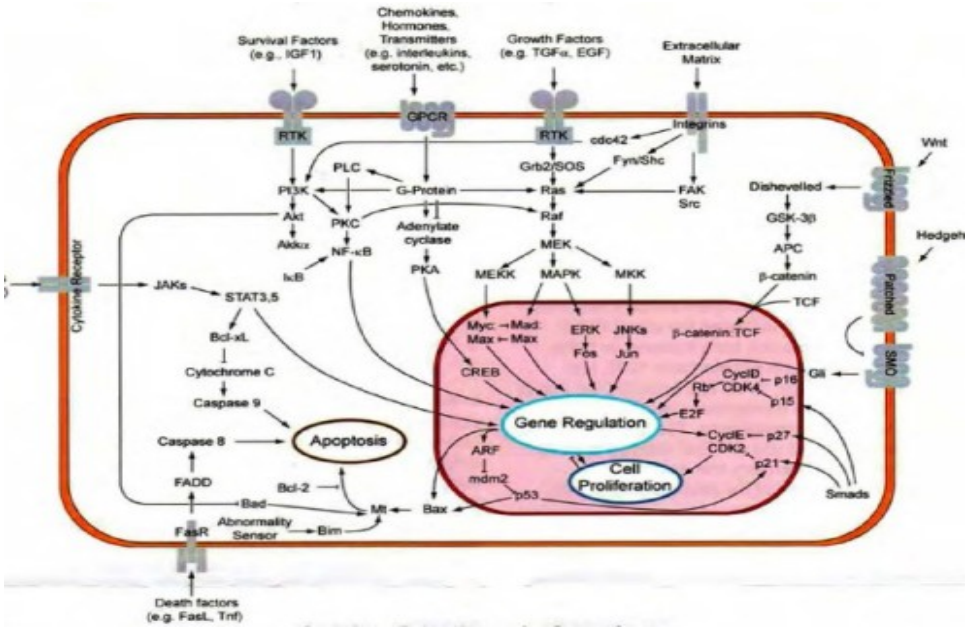
In the “Therapeutic effects of pulsed magnetic fields on joint diseases~. Bassett C. (Bioelectric Research Centre, Columbia University New York) applied time-varying pulsed magnetic fields designed to induce voltages similar to those produced nominally during the dynamic mechanical deformation of connective tissues in an effort to control cellular function and understand the mechanism of PEMF treatment and concluded: “As a result, a wide variety of challenging musculoskeletal disorders has been treated successfully over the past two decades. As understanding of mechanisms expands, specific requirements for field energetics are being defined and the range of treatable ills broadened. These include nerve regeneration, wound healing, graft behaviour, diabetes, and myocardial and cerebral ischemia (heart attack and stroke), among other conditions. Preliminary data even suggest possible benefits in controlling malignancy•.

The Dynamics of Pain and PEMF Therapy

For most individuals, aside from the multiple benefits of the therapy, one of the most relevant effects of PEMF therapy is the improvement of painful conditions regardless of their origin. During the last 100 years, theories of pain mechanism have evolved from specificity and summation models to the popular gate control theory. The latter pain theory, proposed by Melzack/Wall/Casey (Wall and Melzack, 1989) has become the most important development in the field of pain management. Pain perception is no longer a straightforward afferent transmission of pain signal. In biology, signal transduction is a mechanism that converts a mechanical or chemical stimulus to a cell into a specific cellular response. Signal transduction starts with a signal to a receptor, and ends with a change in cell behaviour. Trans membrane receptors move across the cell membrane, with half of the receptor outside the cell and the other half inside the cell. The signal, such as a chemical signal, binds to the outer half of the receptor, which

changes its shape and conveys another signal inside the cell. Sometimes there is a long cascade of signals, one after the other. Eventually, the signal creates a change in the cell, either in the DNA of the nucleus or the cytoplasm outside the nucleus.

Overview of signal transduction pathways



In the chronic pain state, pain signal generation can actually occur in the central nervous system without peripheral noxious stimulation. In pain management, modulation of the pain signal transmission is a far better choice than neural destruction, and that

can be achieved with PEMF. Scientific evidence shows that acute persistent pain eventually sensitizes wide dynamic neurons in the dorsal horn of the spinal cord, the wind-up phenomenon, constituting the basis of developing chronic pain syndromes (Kristensen, 1992). Persistent and excessive pain has no biological good longor necessary function. It is actually harmful to our well-being. Therefore, pain needs to be treated as early and as completely as possible and not to be left alone (Adams, et al 1997).

The primary symptom in most patients with disorders affecting the soft tissue is pain. In many patients, daily activities are limited as pain causes a restriction of the range of movements. Causes of soft tissue pain can be depicted as muscular-skeletal, neurologic, vascular, and referred visceral-somatic or articular (Cailliet, 1991). Early reports of applying electrical current to treat pain date back to before 1800 (Ersek, 1981).

PEMF therapy has successfully been used for the control of pain associated with rotator cuff tendonitis, multiple sclerosis, carpal tunnel syndrome, and pen-arthritis (Battisti et al, 1998; Lecaire et al, 1991). An improvement was observed in 93% of patients suffering from carpal tunnel pain and in 83% in cases of rotat or cuff tendonitis. PEMF therapy was also used for treatment of migraine, chronic pelvic pain, neck pain, and whiplash injuries (Rosch et al, 2004).

PEMF Therapy Reduces Pain

Many studies have demonstrated the positive effects of PEMF therapy on patients with pain, even as opposed to receiving traditional treatment as well as against a placebo group getting no treatment. Some studies focused on the rapid, short-term relief while others demonstrate the long-term effects. The effectiveness of PEMF therapy has been demonstrated in a wide variety of painful conditions. In a study entitled: “Double blind, placebo-controlled study on the treatment of migraine with PEMF”, Sherman R. et.al. (Orthopedic Surgery Service, Madigan Anny Medical Centre, Tacoma, WA, USA) evaluated 42 subjects who met the International Headache Society’s criteria. During the first month of follow-up with exposure to PEMF, 73% of those receiving actual exposure, reported decreased headaches with 45% a substantial decrease and 14% an excellent decrease. Ten of the 22 subjects who had received actual exposure received 2 additional weeks of actual exposure, after their initial month. All showed decreased

headache activity with 50% a substantial decrease and 38% an excellent decrease. Sherman R. et.al concluded that exposure to PEMF for at least 3 weeks is an effective, shortterm intervention for migraine.

Jorgensen W. et.al. (International Pain Research Institute, Los Angeles, CA, USA) studied the effects of PEMF on tissue trauma and concluded: ·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". Patients with typical cases such as dysmenorrhoea, endometriosis, ruptured ovarian cyst, acute lower urinary tract infection, post-operative haematoma, and persistent dyspareunia who had not received analgesic medication were treated with pulsed magnetic field treatment and evaluated. The results showed that 90% of the patients experienced marked, even dramatic relief, while 10% reported less than complete pain.

Heden P, Pilla AA. (Department of Plastic Surgery, Stockholm, Sweden) studied the Effects of pulsed electromagnetic fields on postoperative pain in breast augmentation patients. She notes: "Postoperative pain may be experienced after breast augmentation surgery despite advances in surgical techniques, which minimize trauma. The use of pharmacological analgesics and narcotics may have undesirable side effects that can add to patient morbidity". This study was undertaken to determine if PEMF could provide pain control after breast augmentation. Postoperative pain data were obtained and showed that pain had decreased in the treated patient group by nearly a factor of three times that for the control group. Patient use of postoperative pain medication correspondingly also decreased nearly three times faster in the active versus the sham groups. Heden P, Pilla AA. Concluded: "Pulsed electro-magnetic field therapy, adjunctive to standard of care, can provide pain control with a non-invasive modality and reduce morbidity due to pain medication after breast augmentation surgery•.

The Clinical Rheumatology Journal, volume 26-1, January 2007 (Springer London) reported on the Effectiveness of PEMF therapy in lateral epicondylitis by Kaan Uzunca , Murat Birtane and Nurettin Ta~tekin (Trakya University Medical Faculty Physical Medicine and Rehabilitation Department, Edime, Turkey): We aimed to investigate the efficacy of PEMF in lateral epicondylitis comparing the modality with sham PEMF and local steroid injection •. Patients with lateral epicondylitis were randomly and equally distributed into three groups. One group received PEMF, another sham PEMF, and the third group a corticosteroid + anaesthetic agent injection.

Pain levels during rest, activity, night-time, resisted wrist dorsiflexion, and forearm supination were investigated with visual analog scale (VAS). Pain threshold on elbow was determined with an Algometer. All patients were evaluated before treatment, at the third week and the third month. Pain levels were significantly lower in the group treated with the local steroid at the third week but the group treated with PEMF had lower pain during rest, activity and nighttime than the group receiving steroids at the third month.

Lau (School of Medicine, Loma University, USA) reported on the application of PEMF therapy 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.

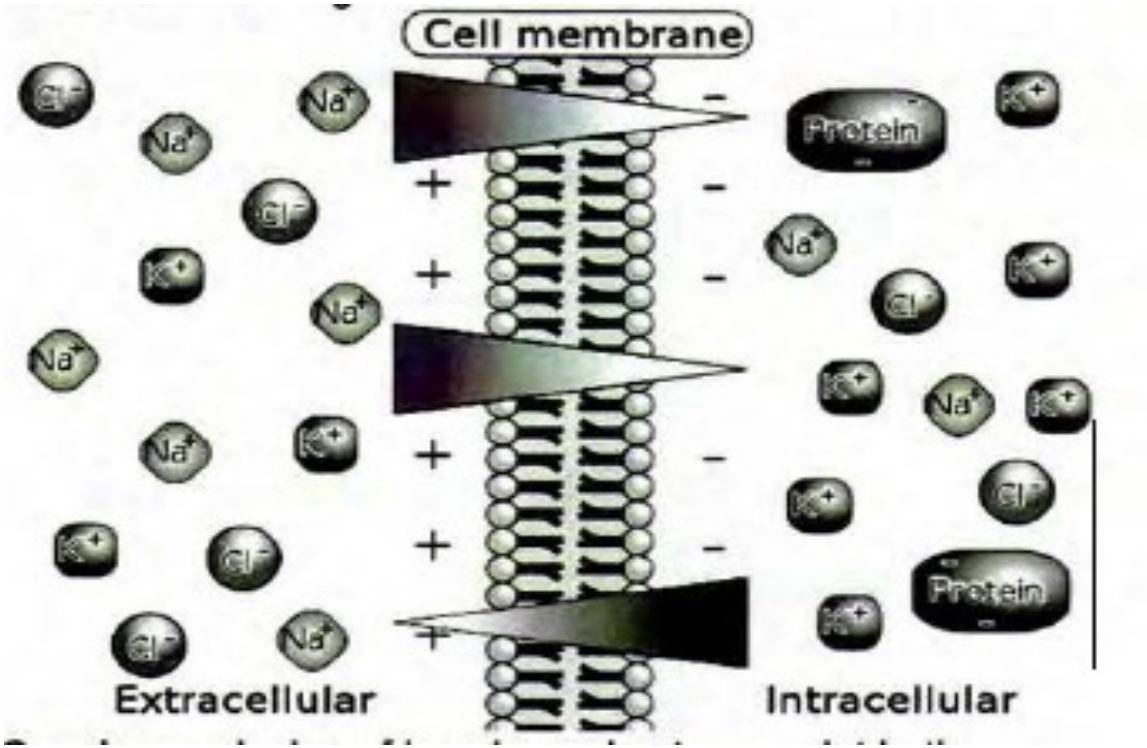
Riva Sanseverino, E. et.al. (Universita di Bologna, Italy) studied the therapeutic effects of PEMF on joint diseases, in chronic as well as acute conditions on more than 3,000 patients over a period of 11 years. Follow-up was pursued as constantly as possible. Pain removal, recovery of joint mobility and maintenance of the improved conditions represented the parameters for judging the results as good or poor. The chi-square test was applied in order to evaluate the probability that the results are not casual. A general average value of 78.8% of good results and 21 .2% of poor results was obtained. A higher, 82% of good results were observed when single joint diseases were considered and 66% of good results with respect to multiple joint diseases (polyarthrosis). The high percentage of good results obtained and the absolute absence of both negative results and undesired side-effects led to the conclusion that PEMF treatment is an excellent physical therapy in cases of joint diseases.

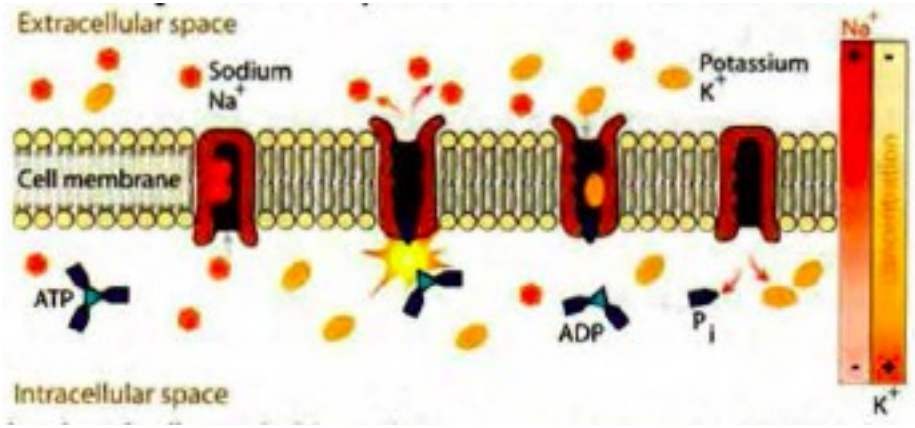
PEMF Therapy Blocks Pain

PEMF therapy has shown the trans-membrane potential, to be effective at reducing pain both in the short-term and in the long-term. The ways by which PEMF therapy relieves pain include pain blocking, decreased inflammation, and increased cellular flexibility and increased blood and fluids circulation.

("TMP") is the voltage difference (or electrical potential difference) between the interior and exterior of a cell. Differences in concentration of ions on opposite sides of a cellular membrane produce the TMP. The largest contributions usually come from sodium (Na+) and chloride (Cl-) ions, which have high concentrations in the extracellular region, and potassium (K+) ions, which along with large protein anions have high concentrations in the intracellular region.

Opening or closing of ion channels at one point in the membrane produces a local change in the TMP, which causes electric current to flow rapidly to other points in the membrane.

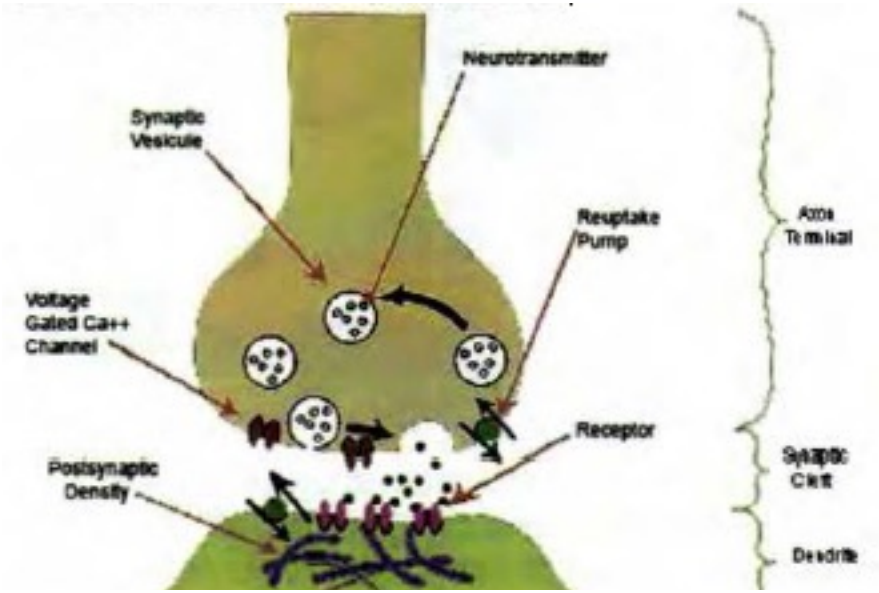




The sodium-potassium pump uses energy derived from ATP to exchange sodium for potassium ions across the membrane.

In electrically excitable cells such as neurons, the TMP is used for transmitting signals from one part of a cell to another. In non-excitable cells, and in excitable cells in their baseline states, the TMP is held at a relatively stable value, called the resting potential. For neurons, typical values of the resting potential range from -70 to -80 mV (mill Volts); that is, the interior of a cell has a negative baseline voltage. Opening and closing of ion channels can induce a departure from the resting potential, called a depolarization if the interior voltage rises (say from -70 mV to -65 mV), or a hyper polarization if the interior voltage becomes more negative (for example, changing from -70 mV to -80 mV).

In excitable cells, a sufficiently large depolarization can evoke short-lasting all-or-nothing event called an action potential, in which the TMP very rapidly undergoes a large change, often reversing its sign. Special types of voltage-dependent ion channels that generate action potentials but remain closed at the resting TMP can be induced to open by a small depolarization.



In a lecture on Pain Reduction, Dr. D. Laycock, Ph.D. Med. Eng. MBES, MIPEM, B.Ed., inspired by the works of Adams, et al 1997, explains how PEMF therapy affects pain transmission at the levels of the neurons. ·it is necessary to understand the mechanism of pain transmission to understand how pain blocking can take place with PEMF therapy. Pain is transmitted along the ne1Ve cells by an electric signal. This signal encounters synaptic gaps at inte1Vals. The pain signals are transmitted along ne1Ve cells to pre-synaptic

terminals. At these terminals, channels in the cell alter due to a movement of ions. The TMP 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 nelVe cell. This all happens in about 112000th of a second, as the synaptic gap is only 20 to 50 nm (nano meters) wide. As the pain signal, in chemical form, approaches the post-synaptic cell, the membrane changes and the signal is transferred.

During quiescent times, cells possess a small charge of about-70mV between the inner and outer membranes. When a pain signal arrives, it temporarily depolarizes the nociceptive cell and raises the cell TMP to +30mV. This increase is sufficient to open channels in the cell membrane allowing the exchange of the sodium (NA+) and potassium (K +) ions, which then trigger exocytosis of neurotransmitters via synaptic vesicles. These neurotransmitters diffuse into the synaptic gap. Once this process has occurred, the cell depolarizes back to its previous level of-70mV. Research by Warnke established that the application of PEMF therapy has an effect on the quiescent potential of the neuronal synaptic membrane (Warnke, 1983; Warnke, et al 1997). It suggested that the effect is to lower the potential to a hyperpolarized level of-90mV. When a pain signal is received, the TMP has to be raised again in order to fire an action potential via neurotransmitters but it only achieves to raise the cell TMP to an approximate +10mV. This potential is well below the threshold of +30mV necessary to release the neurotransmitters into the synaptic cleft and the pain signal is effectively blocked".

By causing a hyperpolarized state at the neuronal membrane, PEMF therapy effectively blocks pain as it prevents the threshold necessary to transmit the pain signal to be reached. That PEMF therapy effectively reduces pain in the short and long-term has been demonstrated but it is unclear whether the pain blocking mechanism provides temporary relief while treatment occurs or can also lead to permanent changes with repeated treatments.

PEMF Therapy Decreases Inflammation

Several factors contribute to inflammation including injury, tissue damage, a poor localized circulation with swelling and the formation of edema. Inflammation causes pain. Clinical studies have demonstrated that PEMF therapy has been successful in reducing inflammation. Therefore, by reducing inflammation, pain also decreases. Several factors influence tissue inflammation and the processes by which PEMF therapy operates to reduce inflammation include complex mechanical, electrical, chemical, and magnetic processes that take place as PEMF therapy increases circulation and cellular activity

PEMF Increases Blood Circulation

In June 2004, The Faseb Journal states: •pf MF therapy has been shown to be clinically beneficial in repairing bones and other tissues, but the mechanism in action is unclear. The results of a study done at the New York University Medical Centre (Institute of Reconstructive Plastic Surgery, NY, NY, USA) demonstrates that electro-magnetic fields increased angiogenesis, the growth of new blood vessels, in vitro and in vivo through the endothelial release of FGF-2, fibroblast growth factor-2. The delivery of PEMF therapy in low doses

Identical to that currently in clinical use significantly increased endothelial cell proliferation and tubulisation, which are both important processes for vessel formation. The ability of PEMF to increase cell pro/if eration was unique to endothelial cells, which seemed to be the primary target of PEMF stimulation, releasing a protein in a paracrine fashion (or signalling to adjacent cells and other types of cells) to induce changes in neighbouring cells and tissues. Since direct stimulation did not produce significant changes in osteoblast proliferation, the ability of PEMF therapy to enhance the healing of complicated fractures is likely the result of increased vascularity rather than a direct effect on osteogenesis as previously believed.

The coordinated release of FGF-2 suggests that PEMF therapy may facilitate healing by augmenting the interaction between osteogenesis and blood vessel growth. As such, PEMF therapy may offer distinct advantages as a non-invasive and targeted modality that is able to release several growth factors to achieve therapeutic angiogenesis. The fibroblast and endothelial cells are

made to go embryonic due to drastic changes in ionic concentrations in the cells' cytoplasm and therefore the cells' nuclei. These ionic concentrations react with the cell DNA opening up some gene sets and closing down others. It is apparently the rapid onset of a strong-pulsed electric field generated by the pulsed magnetic field, which causes some cell ion gate types to open and be force fed ions by the same electric field". As demonstrated in the following study entitled: "Impulse magnetic-field therapy for erectile dysfunction: a double blind, placebo-controlled study", increased microcirculation leads to improvements in macro-circulation. This double-blind, placebo-controlled study by Pelka R. Et.al. (Universitat der Bundeswehr Munchen, Neubiberg/Munich, Germany) assessed the efficacy of three weeks of PEMF therapy for erectile dysfunction {ED). In the active-treatment group, all efficacy endpoints were significantly improved at study end with 80% reporting increases in intensity and duration of erection, frequency of genital warmth, and general well being. Only 30% of the placebo group noted some improvement in their sexual activity; 70% had no change. No side effects were reported.

PEMF therapy has proven efficacious in increasing the flow of ions and nutrients as well as blood flow. Through the same processes, vital organs such as the liver, kidneys and colon are able to rid themselves of impurities thus detoxifying the body and allowing better organ functionality.

PEMF Increases Cellular Membrane Permeability

As early as 1940, it was suggested that magnetic fields might influence membrane permeability as it affects the TMP and the flow of ions in and out of the cells. 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 and lymphatic systems; 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 voltage difference between the inner and outer membrane referred to as the membrane resting potential that ranges from -70 to -80 mV. This causes a steady flow of ions through its voltage dependant

ion channels. In a damaged cell, the potential is raised and an increased sodium inflow occurs. As a result, interstitial fluid is attracted to the inner cellular space, resulting in swelling and edema. The application of PEMF to damaged cells accelerates the re-

establishment of normal potentials (Sansaverino) increasing the rate of healing and reducing swelling. In biology, depolarization is a change in a cell's TMP, making it more positive or less negative. In neurons and some other cells, a large enough depolarization may result in an action potential. Hyper polarization is the opposite of depolarization, and inhibits the rise of an action potential.

If a cell has a resting potential of-70mV, and the membrane potential rises to -50mV, then the cell has been depolarized. Depolarization is often caused by influx of cations, e.g. Na+ through Na+ channels, or Ca2+ through Ca2+ channels. On the other hand, efflux of K+ through K+ channels inhibits depolarization, as does influx of Cl- {an anion) through Clchannels. If a cell has K+ or·CI- currents at rest, then inhibition of those currents will also result in a depolarization. As the magnetic field created by PEMF therapy expands through the living tissue, it induces an electron flow, or current in one direction. As it collapses, the direction is reversed. Electrons always flow from a negative (cathode) to a positive (anode) potential. Therefore such induced current polarized to push ions toward the positive outside of the cell membrane are blocked, just as no current will flow when the positive terminals of two batteries are connected together. Conversely, current flowing away from the membrane will pull electrons away from it and cause more electrons or negative ions to pile up on its interior surface, thus increasing the potential across the membrane and driving the TMP up towards a normal, healthy value for that cell.

As the electro-magnetic field pulses temporarily hyperpolarize and depolarize the membrane, the ion channels open and close allowing a more efficient ion exchange, as with the sodium-potassium (Na+, K+) pump, thus increasing cellular oxygenation and nutrition as sodium export stimulates several secondary active transporters.

PEMF Increases Cell Metabolism

In a study on Chronic Fatigue Syndrome and Electro medicine, Thomas Valone, Ph.D., showed that ~amaged or diseased cells present an abnormally low TMP, about 80% lower than healthy cells. This signifies a greatly reduced metabolism and, in particular, impairment of the electrogenic Na+! K+ pump activity and, therefore, reduced ATP (Adenosine Tri-Phosphate) production. The Na+/ K+ pump within the membrane forces a ratio of 3Na+ ions out of the cell for every 2K+ ions pumped in for proper metabolism. An impaired Na+/ K+ pump results in edema (cellular water accumulation) and a tendency toward fermentation, a condition known to

be favourable toward cancerous activity. French researcher Louis C. Kervran demonstrated that Sodium plus Oxygen plus Energy {ex: magnetic) nuclearly transmutes into Potassium as follows:

11 Na23 + 8 01s +energy= 19 K39

This nuclear process is accomplished with low heat, in a low

rate of thermal decomposition, which is the most important and commonly occurring phenomenon of Nuclear Fusion in Biology.

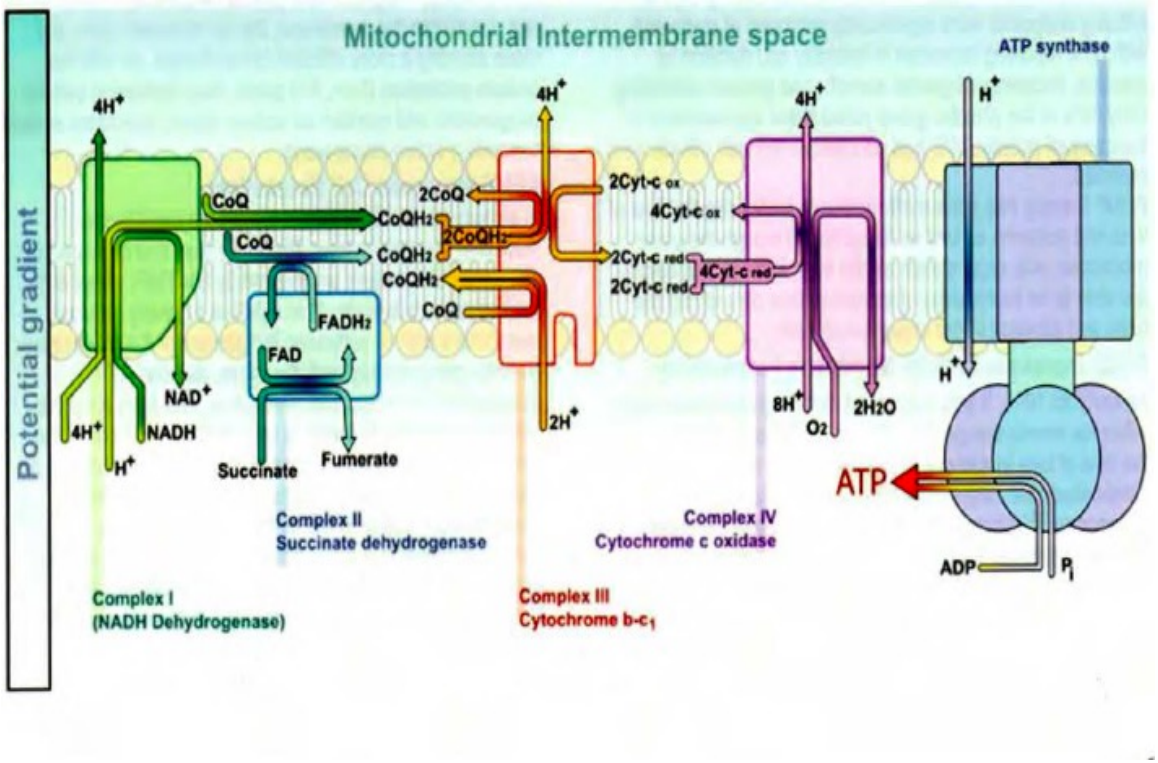
As a result, utilization of oxygen in the cells increases and the body increases production of its own energy supplier (ATP). The organism becomes more stable and efficient; toxins and waste products are more rapidly broken down. The body's natural regulatory mechanisms are reinforced and healing processes accelerated.

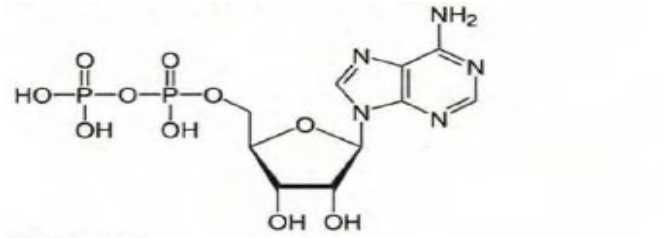
Free radical proliferation is linked to pathological changes that cause cellular malfunction or mutation (i.e. cancer) as well as protein degradation. Free radicals also play a large role in causing damage to all cells of the body but particular1y that of the immune system. According to studies, free radicals also "deplete cellular energy- by interfering with mitochondrial function and contribute to a shortened lifespan. Cellular energy generation in the mitochondria is both a key source and a key target of oxidative stress in the cells. Seeking an electron to complete the radical, free radicals cause chain reactions as electrons are ripped from molecules, creating another free radical. Antioxidants such as vitamin A, vitamin E, selenium and coenzyme Q10 supply free electrons and are usually prescribed to provide limited relief in counteracting free radical ravages. However, electronic antioxidants produced by PEMF therapy can also satisfy and terminate free radicals by abundantly supplying the key ingredient usually found only in encapsulated antioxidant supplements … the electron (Thomas Valone, Ph.D.). On the biophysical level, as PEMF therapy increases the circulation of electrons across the membrane, another parallel phenomenon seems to occur: the acceleration of ATP synthesis and of other aspects of the cell's biochemical anabolism. The electrons that are drawn to the inner membrane elevate the TMP and increase the ionic charge on the interior of the cell.

In 1976, Nobel Prize winner Dr. Albert Szent-Gyorgi established that structured proteins behave like diodes or rectifiers. A diode passes electricity in only one direction. He proposed that cell membranes can rectify an induced voltage and this rectifying property of cell membranes can cause changes in the ion concentration of the inner and outer surfaces of the cell membrane in such a way as to increase the TMP and effectively stimulate the activity of the Na+/ K + pump. Cell health is directly affected by the health of the Na+/ K+ pump, which is directly proportional to the TMP. Based on these biophysical principles, an endogenous high voltage EMF potential of sufficient strength will theoretically stimulate the TMP, normal cell metabolism, the sodium pump, ATP production and healing. This has already been found in the literature: “TMP is proportional to the activity of this pump and thus to the rate of healing. · Furthermore, “increases in the TMP have also been found to increase the uptake of amino acids. · (Dr. Albert Szent-Gyorg1) Electro-medicine therefore, appears to connect to and recharge the storage battery of the TMP. This is important, as increasing the supply of nutrients is also an effective aid to cell repair. This is particularly true in trauma where circulation has been impaired by crushed or severed blood vessels or by the inflammation and swelling that compress capillaries. Blocking the flow to both the injured and uninjured cells.

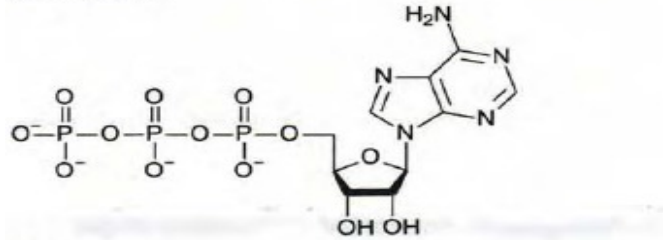
PEMF Increases Energy Storage and Cellular Activity

At the sub-atomic level, as the pulsed fields expand and collapse through a tissue, the protein molecules, such as the cytochromes in the cells' mitochondria, gain electrons and, in doing so, store energy. The diagram below describes the electron transport chain:





ADP structure



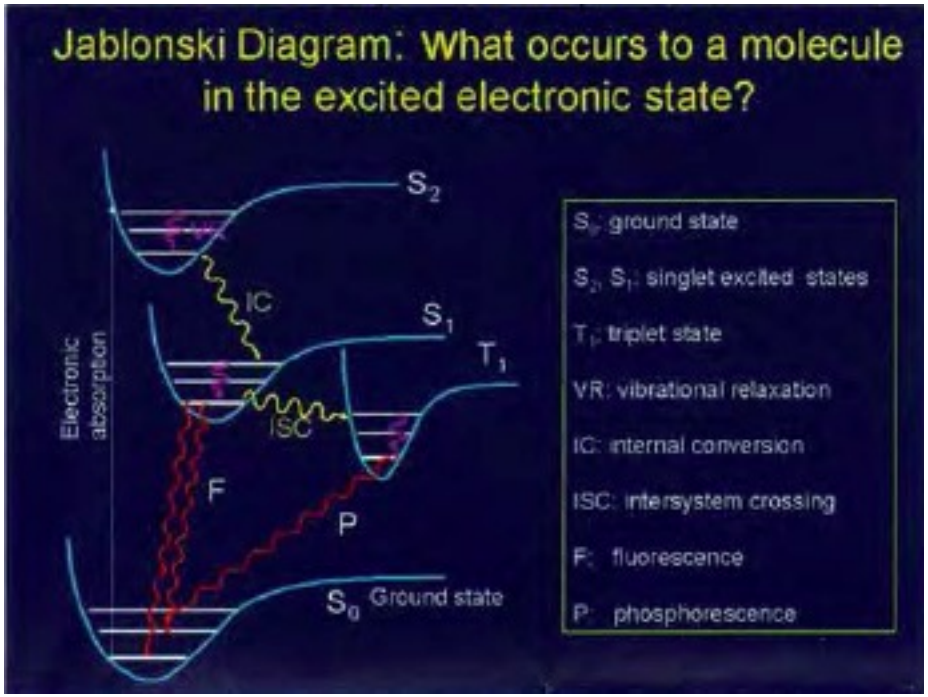
Even though the instantaneous peak magnetic energy amplitudes are very high, the average magnetic amplitudes generated by PEMF therapy remain low, the average total energy transmitted to the tissues is not powerful enough to create heat within the cells, nor for the cells' atoms to vibrate much and cause a thermal increase, nor for an electron to jump to a higher orbit and emit heat as it returns to its orbit of origin. There is only sufficient average energy for the electron-spin to be increased, thus, energy gets stored in the cells' mitochondria by converting ADP (Adenosine Triphosphate) to ATP molecules more rapidly.

ATP structure

The ATP molecules store and transport the energy that is then used in all the metabolic functions of living cells. Understanding the effects of PEMF therapy at the atomic level requires a basic understanding of Quantum Mechanics that is provided here. Solving the Schrodinger equation for a molecule and determining probable amplitude for its electrons over an infinite number of possible trajectories yields the vibrational states of a molecule. This describes how the quantum state or wave function of a molecule or physical system changes in time. A diatomic molecule, which only involves one vibrational degree of freedom (the stretching of the bond between the electron and the position) provides a simple description (Atkins et al, 2002).

Quantum mechanical considerations show that during the electronic excitation of a particular molecule at the same orbital state, the energy of an excited triplet state (T1) is lower than that of its corresponding singlet state (S1). In biomolecules, the non-radiative crossing from the state S2 to S1 is generally the dominant mechanism. This crossing between two electronic states of the same spin multiplicity is called internal conversion ("IC") (Atkins et al, 2002). The IC process is then followed by a rapid vibrational relaxation (decrease) where the excess vibrational energy is dissipated into heat, the molecule now ending up at the lowest, zero point vibrational level of the S1 electronic state. From here, it can return to the ground electronic state SO by emitting a

Photon (radioactively). The time-varying magnetic fields associated with PEMF therapy apparently affect electronic states via the intercrossing system ("ISC"), which is an excitation from state Si to Ti, where Ti is the corresponding triplet state (2 electrons are unpaired). The ISC type of crossing is heavily affected by the spin-orbit coupling, which relaxes the spin property by mixing with an orbital character (Szent-Gyorgyi A, 1976; Atkins et al, 2002). The ISC type of crossing leads to phosphorescence rather than fluorescence with radically different heat properties. Heavy metals, molecular oxygen having a triplet ground state, paramagnetic molecules such as hemoglobin, and heavy atoms such as iodine increase the inter-s stem crossin rate Prasad, 2003.



In shifting positions around an atomic nucleus, an electron generates energy and emits a magnetic resonance of specific frequency. Thus, the magnetic resonance field frequency of the various body tissues and organs is a product of the individual atomic, molecular and cellular frequencies specific to the molecules that constitute the particular tissue or organ. PEMF therapy therefore confuses the specific inherent magnetic resonance and temporarily modifies it in each atom, molecule, cell, and thus, tissue and organ.

From the perspective of biophysics, physiological markers represent a level of "order or disorder" in the magnetic resonance of a normal atom that correlates to internal and external factors. The Pulsed Electro-Magnetic Fields generated by PEMF therapy devices provide sufficient energy to affect the magnetic resonance of the atom as the electron is energized. When a disruption in the magnetic resonance occurs, the magnetic resonance of the electrons at the atomic level also exhibits a change, a phase shift that disturbs and breaks the once orderly pathways of communication that is usually transmitted from atom to

molecule, molecule to cell, cell to tissue, and tissue to organ. In doing so, the phase shift influences the physical and chemical characteristics of the physiological markers.

PEMF therapy has proven beneficial in many ways for the various energetic body functions. All of the many types of living cells that make up the tissues and organs of the body are tiny electrochemical units. They are powered by a “battery· that is continually recharged by the cells’ metabolic chemistry in a closed loop of biological energy.

PEMF Increases Cellular Membrane Flexibility and Elasticity

A study entitled “Modulation of collagen production in cultured fibroblasts by a low-frequency pulsed magnetic field” by Murray J. et.al. (Biochim Biophys Acta) shows that the total protein synthesis was increased in confluent cells treated with a pulsed magnetic field for the last 24 h of culture as well as in cells treated for a total of 6 days. However, in 6 day-treated cultures, collagen accumulation was specifically enhanced as compared to total protein, whereas after short-term exposure, collagen production was increased only to the same extent as total protein. These results indicate that a pulsed magnetic field can specifically increase collagen production, the major differentiated function of fibroblasts, possibly by altering cyclic-AMP metabolism.

PEMF therapy successfully increases membrane flexibility by increasing the synthesis of collagen, a crucial protein that supports membrane elasticity, within the fibroblasts. In doing so, PEMF therapy increases tissue and muscle flexibility and, therefore, increases range of motion, usually within minutes.

PEMF Stimulates Cellular Communication and Replication

DNA synthesis is linked to pulsed, low intensity magnetic fields (Liboff et al, 1984; Rosch et al, 2004). Proteins are conductors of electricity. When exposed to strong fields, proteins are subject to electrophoresis. The Ribonucleic Acid (“RNA”) messengers that are synthesized from a Deoxyribonucleic Acid (“ONA”) template during transcription mediate the transfer of genetic information from the cell nucleus to ribosomes in the cytoplasm and serve as a template for protein synthesis.

Since RNA mechanically influences the DNA and encoded proteins influence RNA, the flow of information to and from genes may be linked to changing magnetic fields (Einstein, 1977; Goodman et al, 1983). Since magnetic fields interact with moving electrical charges and recent studies (Dandliker et al, 1997) show that DNA conducts electrons along the stacked bases within the DNA double helix, electro-magnetic fields may initiate transcription of the precursor mRNA by accelerating electrons moving within the DNA helix (McLean et al, 2003).

PEMF Increases Cellular Genesis (Cellular Growth and Repair)

The many intra and inter cellular processes and activity stimulated by PEMF therapy lead too faster cellular and tissue regeneration. This fact is shown by the results of many studies on a variety of tissues, including bones, spine, cartilage, intestines, blood vessels, nerves, brain, and muscles.

In December 2004, the Swiss Medical Tribune stated that PEMF therapy provided: improvement of blood circulation, relief from pain, improvement of bone healing and the stimulation of nerve cells. Not only is the PEMF therapy effective in disease condition: it is an excellent means of preventing stress, assisting regeneration and recovery after sports exertion… Through metabolic activation and blood circulation more nutrients and oxygen are available to muscle cells, less damage is experienced, and efficiency is improved.

PEMF and the spine

In a long-term study entitled: “Spine fusion for disco genic low back pain: outcome in patients treated with or without pulsed electromagnetic field stimulation·, Marks RA. (Richardson Orthopaedic Surgery, TX, USA) randomly selected 61 patients who underwent lumbar fusion surgeries for disco genic low back pain between 1987 and 1994 and had failed to respond to preoperative conservative treatments. Average follow-up time was 15.6 months postoperatively. Fusion succeeded in 97.6% of the 42 patients who received PEMF stimulation for only 52.6% of the 19 patients who did not receive electrical stimulation of any kind. A similar study by Richard A. Silver, M.D. (Tucson Orthopaedic & Fracture Surgery Associates, Ltd., Tucson, AZ, USA) with 85 patients who

had undergone surgery of posterior lumbar interbody fusion (PLIF) and had risk factors associated with a poor prognosis for healing, including smoking, prior back surgery, multiple spinal levels fused, diabetes mellitus, and obesity,

Roentgenographic examination and clinical evidence indicated that all but two patients achieved successful fusion. Of the 83 patients with successful spinal fusion, 29 (34.9%) were assessed as “excellent,” 45 (54.2%) as “good,” 3 (3.6%) as “fair”, and 6 (7.2%) as “poor”. Adjunctive treatment with PEMF appeared effective in promoting spinal fusion following PLIF procedures across all patient subgroups.

PEMF on bone and cartilage

In a study entitled: “Modification of biological behaviour of cells by Pulsing Electro-magnetic fields”, 20 subjects of ages between 57 and 75 years with decreased bone mineral density as defined by a bone densitometer, were treated with PEMF therapy during a period of 12 weeks by Ben Philipson, Curatronic Ltd. (University of Hawaii School of Medicine, HI, USA). After a period of 6 weeks, the bone density rose in those patients with an average of 5.6%. Properly applied pulsed electromagnetic fields, if scaled for whole body use, has clear clinical benefits in the treatment of bone diseases and related pain, often caused by micro-fractures in vertebrae. In addition, joint pain caused by worn out cartilage layers can be treated successfully, through electromagnetic stimulation. PEMF application promotes bone union by electric current induction, which changes the permeability of cell membrane allowing more ions across, affects the activity of intracellular cyclic adenosine monophosphate (cAMP) and cyclic guanosine monophosphate (cGMP), and accelerates osteoblast differentiation by activation of p38 phosphorylation. PEMF stimulation also increases the partial oxygen pressure and calcium transport. Repair and growth of cartilage is thus stimulated, preventing grinding of the bones.

PEMF and tendonitis

The department of rheumatology at Addenbrookes Hospital carried out investigations into the use of PMFT for the treatment of persistent rotator cuff tendonitis. PEMF 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.

PEMF and intestines

An experimental study was designed to investigate the effect of electromagnetic field therapy on intestinal healing and to compare small and large intestinal anastomoses, or connections between the loops of the intestines, by Nayci A. et.al. Cakmak M, Aksoyek S, Renda N, Yucesan s. (Department of Pediatric Surgery, Mersin University Medical Faculty, Turkey). The study demonstrated that electromagnetic field stimulation provided a significant gain in anastomotic healing in both small and large intestine, and a significant increase in both biochemical and mechanical parameter

PEMF and the brain

A 4-week double blind, placebo-controlled study conducted by Uni der Bundeswehr (Munich, Germany) assessed the efficacy of PEMF Therapy for Insomnia. One hundred one patients were randomly assigned to either active treatment (n = 50) or placebo {n = 51) and allocated to one of three diagnostic groups: sleep latency; interrupted sleep; or nightmares. The results showed 70% {n = 34) of the patients given active PEMF treatment experienced substantial or even complete relief of their complaints; 24 % (n = 12) reported clear improvement; 6% (n = 3) noted a slight improvement. Only one placebo patient (2%) had very clear relief; 49% (n = 23) reported slight or clear improvement; and 49% (n = 23) saw no change in their symptoms. No adverse effects of treatment were reported.

Stunning results were obtained in a study entitled “Protection against focal cerebral ischemia following exposure to a pulsed electro-magnetic field”. Grant G. et.al. of the Department of Neurosurgery, Stanford University, CA, USA stated: MThere is evidence that electro-magnetic stimulation may accelerate the healing of tissue damage following ischemia. Exposure to pulsed electro-magnetic field attenuated cortical ischemia edema on MRI at the most anterior coronal level by 65%. On histological examination, PEMF

exposure reduced ischemic neuronal damage in this same cortical area by 69% and by 43% in the striatum. Preliminary data suggest that exposure to a PEMF of short duration may have implications for the treatment of acute stroke·.

PEMF and multiple sclerosis

At the Biologic Effects of Light 1998 Symposium, Richards TL, Acosta-Urquidi, J. explains the effects of pulsing magnetic field on brain electrical activity in multiple sclerosis: "Multiple sclerosis (MS) is a disease of the central nervous system. Clinical symptoms include central fatigue, impaired bladder control, muscle weakness, sensory deficits, impaired cognition, and others. The cause of MS is unknown, but from histologic, immunologic, and radiologic studies, we know that there are demyelinated brain lesions (visible on MRI) that contain immune cells such as macrophages and T-cells (visible on microscopic analysis of brain sections). Recently, a histologic study has also shown that widespread axonal damage occurs in MS along with demyelination. What is the possible connection between MS and bio-electromagnetic fields? We recently published a review entitled "Bio electromagnetic applications for multiple sclerosis, • which examined several scientific studies that demonstrated the effects of electromagnetic fields on nerve regeneration, brain electrical activity (electro-encephalography), neurochemistry, and immune system components. All of these effects are important for disease pathology and clinical symptoms in Ms·. He referred to a study that evaluated electro-encephalograms (EEG) in response to photic stimulation with flashing lights before and after PEMF exposure. The evidence showed a significant increase in alpha EEG magnitude that was greater in the active group compared to the placebo group demonstrating increased activity.

Richards T. et.al. (Dep. Radiology, University of Washington, WA, USA) confirms the above conclusion in a double-blind study to measure the clinical and sub-clinical effects of an alternative medicine electromagnetic device on disease activity in multiple sclerosis. The MS patients were exposed to a magnetic pulsing device that was either active (PEMF) or inactive (placebo) for two months. Each MS patient received a set of tests to evaluate MS disease status before and after wearing the device. The tests included a clinical rating (Kurtzke, EDSS), patient-reported performance scales {PS), and quantitative electro-encephalography (QEEG) during a language task. Although there was no significant change between pre-treatment and post-treatment in the EDSS scale, there was a significant improvement in the PS combined rating for bladder control, cognitive function, fatigue level, mobility,

spasticity, and vision. There was also a significant change between pre-treatment and post-treatment in alpha EEG magnitude during the language task. Richards T. et.al. stated: “we have demonstrated a statistically significant effect of the. Magnetic pulsing device on patient performance scales and on alpha EEG magnitude during a language task·.

In “Treatment with AC pulsed electromagnetic fields normalizes the latency of the visual evoked response in a multiple sclerosis patient with optic atrophy-, Sandyk R. (Deparlment of Neuroscience at the lnstffute for Biomedical Engineering and Rehabilitation Services of Touro College, Dix Hills, NY, USA) explains: “Visual evoked response (VER) studies have been utilized as supportive information for the diagnosis of MS and may be useful in objectively monitoring the effects of various therapeutic modalities. Delayed latency of the VER, which reflects slowed impulse transmission in the optic pathways, is the most characteristic abnormality associated with the disease. Brief transcranial applications of AC PEMFs in the picotesla flux density are efficacious in the symptomatic treatment of MS and may also re-establish impulse transmission in the optic pathways. A 36-year-old man developed an attack of right-sided optic neuritis at the age of 30. On presentation he had blurring of vision with reduced aeuity on the right and fundoscopic examination revealed pallor of the optic disc. A checkerboard pattern reversal VER showed a delayed latency to right eye stimulation (P100 = 132 ms; normal range: 95-115 ms). After he received two successive applications of AC PEMFs of 7.5 picotesla flux density each of 20 minutes duration administered transcranially, there was a dramatic improvement in vision and the VER latency reverted to normal (P100= 107 ms). The rapid improvement in vision coupled with the normalization of the VER latency despite the presence of optic atrophy, which reflects chronic demyelization of the optic nerve, cannot be explained on the basis of partial or full reformation of myelin. It is proposed that in MS synaptic neurotransmitter deficiency is associated with the visual impairment and delayed VER latency following optic neuritis and that the recovery of the VER latency by treatment with PEMFs is related to enhancement of synaptic neurotransmitter functions in the retina and central optic pathways. Recovery of the VER latency in MS patients may have important implications with respect to the treatment of visual impairment and prevention of visual loss. Specifically, repeated applications of PEMFs may maintain impulse transmission in the optic nerve and thus potentially sustain its viability”.

Sandyk R. summarizes recent clinical work on the therapeutic effects of AC PEMF in MS: •Multiple sclerosis is the third most common cause of severe disability in patients between the ages of 15 and 50 years. The cause of the disease and its pathogenesis

remain unknown. The last 20 years have seen only meagre advances in the development of effective treatments for the disease. No specific treatment modality can cure the disease or alter its long-term course and eventual outcome. Moreover, there are no agents or treatments that will restore premorbid neuronal function. A host of biological phenomena associated with the disease involving interactions among genetic, environmental, immunologic, and hormonal factors, cannot be explained on the basis of demyelization alone and, therefore, require refocusing attention on alterative explanations, one of which implicates the pineal gland as pivotal. The pineal gland functions as a magneto-receptor organ. This biological property of the gland provided the impetus for the development of a novel and highly effective therapeutic modality, which involves transcranial applications of alternating current (AC) PEMFs flux density".

Summary

As evidenced by the many studies cited herein, it is clear that PEMF treatment stimulates many aspects of cellular activity and, in doing so, promotes neural regeneration and brain function, improves neuro-muscular function and general health.

Beyond the complex mechanisms by which it operates remain the health benefits associated with PEMF therapy. PEMF therapy increases blood circulation in and around damaged tissue, and effectively helps damaged cells heal. Generally, PEMF therapy produces one main effect; it stimulates the cell metabolism by increasing the flow of electrons and ions across the cell membrane. This effect involves a chain of processes in the human body, which leads to the improvement of health without side effects including:

- Improved micro-circulation
- Increased supply of oxygen, ions and nutrients to cells
- Increased partial oxygen pressure
- Increased ATP production by excitation of electrons
- Stimulation of RNA and DNA production
- Accelerated protein bio-synthesis by electron and energy transfer

- Anti-oxidation regulation with increased circulation of available electrons
- Increased calcium transport and absorption for stronger bones, joints and muscles
- Enhanced cellular and tissue elasticity with increased collagen production
- Increased cellular genesis promoting bone, cartilage, tendon and soft tissue growth
- Stimulation of cellular repair mechanisms
- Enhanced macro circulation: by mechanically declumping blood cells, alternately dilating and constricting vessels, and through angiogenesis, the growth of new blood vessels
- Accelerated detoxification of cells and organs
- Decreased swelling, inflammation and pain
- Boosting of the immune system, the body's defences, by improving the rolling and adhesion behaviour of white blood cells
- Supporting the body's internal self· regulating mechanisms by activating cellular and molecular processes.

PEMF helps the natural body healing processes by delivering a non-invasive form of repetitive electrical stimulation that requires no direct contact with the skin surface. Magnetic fields have been shown to affect biologic processes and be effective in a wide range of medical conditions. PEMF therapy has proven beneficial in stimulating cellular metabolism, blood and fluids circulation, tissue regeneration and immune system response. PEMF treatment is effective at increasing bone formation and bone density, healing fractures and osteotomies, recovery from wounds and trauma, graft and post-surgical behaviour, recovery from myocarcl1al and brain ischemia (heart attack and stroke), tendonitis, osteoarthritis, and impaired neural function or spasticity from central nervous system diseases such as multiple sclerosis and spinal cord damage. PEMF stimulation offers a safer and more comfortable alternative for urinary incontinence to prior treatments. PEMF therapy improves sports performance, and simply helps to maintain good health. PEMF therapy stimulates muscles, connective tissues, intestines, tendons and cartilage, the brain and peripheral nerve sites. PEMF therapy promotes healing and a return to higher activity levels. Functions that were lost begin to recover. Extensive research has been carried out to determine the mechanism by which this occurs but, for the physiotherapist presented with a wide range of clinical problems, PEMF therapy is an invaluable aid to the clinic. PEMF therapy leaves you feeling relaxed, energized and with a sense of wellbeing.

Pulsed Electromagnetic Field Treatment Frequencies For Conditions

DISEASE	DURATION OF TREATMENT	FREQUENCY	
MUSCULOSKELETAL SYSTEM	Fractures (South Pole)	20 minutes	10 or 20 Hz
	Periostitis, North Pole	20 minutes	6 Hz
	Pseudoarthrosis (nonunion), South Pole	20-30 minutes	10 or 20 Hz
	Osteoporosis (South Pole)	20 minutes	8,9,10, 15 or 19 Hz
	Osteoarthrosis (osteoarthritis), South Pole	20 minutes	8-12 or 18 Hz
	Tendinitis, North pole	10 minutes	8 Hz
	Ligament injuries, South Pole	20 minutes	10-15 Hz
	Frozen shoulder, North Pole	20-30 minutes	7-8 Hz
	Tennis or golf elbow, North Pole	10 minutes	8 Hz
	Dislocations and sprains, North Pole	20-30 minutes	10 Hz
	Strains, North Pole	20 minutes	11-15 Hz
	Herniated disc, North Pole	20-30 minutes	16-20 or 30 Hz
	Rheumatoid arthritis, North Pole	20 minutes	10 or 20 Hz
	Psoriatic arthritis, South Pole	20 minutes	P1

	Fibromyalgia, North Pole	20 minutes	18 Hz
	Musculoskeletal pain, North Pole	20 minutes	10 Hz
	Osteonecrosis/Osteochondrosis, South Pole	20-30 minutes	10, 19 or 20 Hz
CIRCULATION	Hypertension (high blood pressure), South Pole	20-30 minutes (40 minutes for chronic cases)	1-5 Hz
	Arrhythmia, South Pole	20-30 minutes	7-8 Hz
	Angina pectoris), South Pole	20-30 minutes	2-8 Hz
	Arteriosclerosis, South Pole	15 minutes	7-10 Hz
	Circulatory dysfunction, South Pole	15 minutes	7-10 Hz
	Poor blood supply (e.g. diabetic foot, ulcer) South Pole	20 minutes	2-6 or 20 Hz
	Raynaud's syndrome, South Pole	20 minutes	15 Hz
	Lymphatic disorders, South Pole	20-30 minutes	P1
NERVOUS SYSTEM	Stroke, South Pole	15 minutes	7-10 or 20 Hz
	Alzheimer's disease, South Pole	20-30 minutes	2-8 Hz
	Parkinson's disease, South Pole	20-30 minutes	20 Hz

	Headache, South Pole	15 minutes	3 or 6-10 Hz
	Tinnitus, South Pole	20 minutes	10 Hz
	Sleep disorders, South Pole	10-20 minutes	1-5 Hz
	Carpal tunnel syndrome, South Pole	10 minutes	6 or 20 Hz
	Lumbago	15 minutes	10 or 20 Hz
	Sciatica, North Pole	20 minutes	16-20 Hz
	Spinal injuries, North Pole	20 minutes	P1
	Multiple sclerosis, South Pole	20-30 minutes	5, 13 or 20 Hz
	Sensitivity to weather fronts, North Pole	10 minutes	11-15 Hz
	Stress, South Pole	15 minutes	3 or 5 Hz
	Depression, South pole	10 minutes	3 or 20 Hz
	Hyperactivity, South pole		20 Hz
	Nerve pain, North Pole	10 minutes	6 Hz
DIGESTION	Diabetes mellitus, South Pole	15-20 minutes	P1
	Inflamed liver, pancreas, or colon, North Pole	20-30 minutes	P1
	Crohn's disease, North Pole	20-30 minutes	P1

	Dental and oral diseases, South Pole	30 minutes	30 Hz
	Stomach/duodenal ulcer (no bleeding!), North Pole	12 minutes	10 or 20 Hz
	Stomach aches, North Pole	12 minutes	10 Hz
RESPIRATION	Bronchitis, South pole	12 minutes	4 Hz (12 Hz for chronic cases)
	Pneumonia, respiratory diseases, South pole	20-30 minutes	P1
	Asthma, South Pole	20 minutes	7-10 or 12-15 Hz
	Allergy, North pole	10 minutes	5-10 Hz
	Tuberculosis (TB), South Pole	12 minutes	4 Hz
WOUNDS	Wound healing, South pole	15 minutes	1-5 Hz
	Pain associated with wound healing, North Pole	15 minutes	11-15 or 17 Hz
	Bruises, North Pole	15 minutes	10 Hz
	Phantom pain, South Pole	15 minutes	16-19 Hz
	Bruises, North pole	16 minutes	14 Hz
OTHER	Psoriasis, South Pole	20-30 minutes	P1

Chronic pelvic pain, North Pole	20 minutes	5-7 Hz
Menstrual pain, North Pole	20 minutes	5-7 Hz
Cystitis, South Pole	10 minutes	5-8 Hz
Prostatitis, North Pole	10-15 minutes	2-8 Hz
Erectile dysfunction, South Pole	20 minutes	6 Hz
Hepatitis, North Pole	20-30 minutes	P1
Systemic lupus erythemasosus (SLE), North Pole	20 minutes	P1
Chronic blepharitis, North Pole	20-30 minutes	1 or 2 Hz
Glaucoma, atrophy of the optic nerve, South Pole	20-30 minutes	P1