Biological Effects of Pulsed Electromagnetic Field (PEMF) Therapy

By Keith R. Holden, M.D.

Introduction

Pulsed electromagnetic field (PEMF) therapy is effective because time-varying or pulsed electromagnetic fields create microcurrents in the body's tissues. These microcurrents elicit specific biological responses depending on field parameters such as amplitude, frequency, and waveform.

The body contains multiple electromagnetic fields with each tissue and organ having a unique electromagnetic signature. Computerized Axial Tomography (CAT) scans and Magnetic Resonance Imaging (MRI) scans take advantage of these unique signatures to create a map of the body's tissues using pulsed electromagnetic fields. While the diagnostic benefits of PEMFs are accepted and widely used, medical practitioners are still realizing the therapeutic benefits of PEMFs.

In 1954, Japanese scientists first reported on the piezoelectric properties of bone. This finding led to further research showing that damaged bone responded therapeutically to electric fields and pulsed electromagnetic fields. Then in 1995, scientists at the University of Kentucky found that each type of soft tissue responds favorably to specific electromagnetic frequencies.[1]

Since then, peer reviewed clinical research documenting the biological and therapeutic effects of PEMFs has increased dramatically. Despite this research contributing to the development of many types of effective PEMF devices, the Food and Drug Administration (FDA) has cleared relatively few of these devices for treating specific conditions. However, as clinical evidence continues to mount, and as patients drive the demand for effective but safer medical therapies, this will likely change. Since the FDA cleared the first therapeutic PEMF device over 30 years ago, there have been no postmarketing safety alerts issued for any of these devices. This reflects the overall safety of short sessions of therapeutic PEMFs.

The benefits of PEMF therapy have been documented in multiple peer-reviewed clinical studies for a wide range of medical conditions. Randomized double-blind, placebo controlled clinical trials using PEMF therapy have shown beneficial effects for chronic low back pain, fibromyalgia, cervical osteoarthritis, osteoarthritis of the knee, lateral epicondylitis, recovery from arthroscopic knee surgery, recovery from interbody lumbar fusions, persistent rotator cuff tendinitis, depression, and multiple sclerosis.[2,3,4,5,6,7,8,9,10,11]

PEMF therapy and current FDA status

In 1979, the FDA cleared PEMF therapy in the form of electrical bone growth stimulators for use in treating non-union fractures. Subsequently, the FDA cleared PEMF therapy for failed joint fusion following arthrodesis, failed spinal fusion, and congenital pseudoarthrosis. In 1987, the FDA formally "grandfathered" 510(k) marketing clearance to a

high frequency PEMF device for adjunctive therapy in the palliative treatment of postoperative edema and pain in superficial soft tissue. A similar device was given FDA approval in 2008 to deliver what its company calls "targeted microcurrent therapy."

Most recently, in October of 2008, the FDA cleared a PEMF device using repetitive transcranial magnetic stimulation (rTMS) for the treatment of Major Depressive Disorder in adult patients who failed to achieve satisfactory improvement from prior antidepressant medication. In a multicenter clinical trial, approximately half of the patients experienced significant improvement in depression symptoms, and approximately a third of the patients experienced complete symptom relief at the end of six weeks.[12]

The future of PEMF therapy

The future of PEMF therapy is exciting given the findings of early research in a wide variety of health conditions. For example, preliminary data in clinical studies shows rTMS has promise in treating schizophrenia, post-traumatic stress disorder, obsessive-compulsive disorder, Alzheimer's disease, and Parkinson's disease.[13,14,15,16,17]

In relation to cardiovascular disease, studies show how PEMF therapy may reduce blood glucose levels, blood viscosity, total cholesterol, and triglycerides, while raising high-density lipoprotein (HDL).[18,19] These studies will hopefully serve as an impetus for further investigation given that heart disease is the leading cause of death in the United States. Another study shows how PEMF therapy may accelerate the healing of damaged brain tissue following acute stroke.[20]

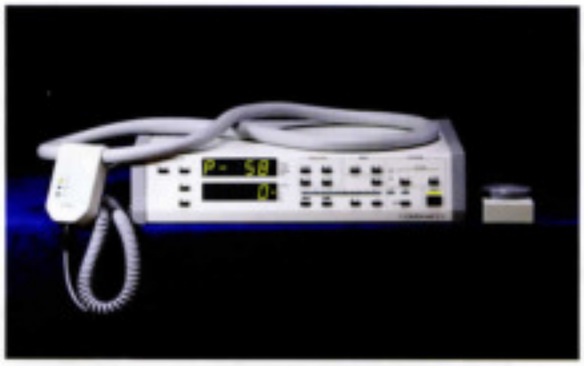
In light of the emergence of drug resistant bacteria, clinical studies show how PEMF therapy could one day become part of the standard of care in inhibiting Staphylococcus aureus infections and augmenting antibiotic therapy.[21,22] Complicating the issue of antibiotic resistance are biofilms, dynamic mucous-like cities in which bacteria live and thrive. Biofilms protect bacteria and assist in bacterial cell-to-cell communication and in the exchange of genetic information. The same bacterium living outside a biofilm is less susceptible to antibiotics when living in a biofilm. Studies indicate PEMF therapy may effectively address this dangerous bacterial diversity.[23,24]

Studies also suggest that PEMF therapy may one day be used to treat cancer. Findings show PEMF therapy induces apoptosis of cancer cells, inhibits the growth of malignant tumors, modulates the immune system via cytokines as an anti-tumor effect, and may act synergistically with chemotherapy and photodynamic therapy to combat tumor growth.[25,26,27,28]

PEMF therapy and osteoporosis

The scientific evidence is accumulating regarding how PEMF therapy may one day gain FDA approval for the prevention and treatment of osteoporosis.[29,30] PEMF therapy improves bone mineral density, increase growth of osteoblasts, and positively influence bone remodeling via cytokines, prostaglandins and cell growth factors.[31,32,33,34]

In the clinical setting, it is important to document objective measures of improvement based on the therapy chosen. Bone density test scores are used to monitor the response to therapy for osteoporosis and osteopenia over the long term.

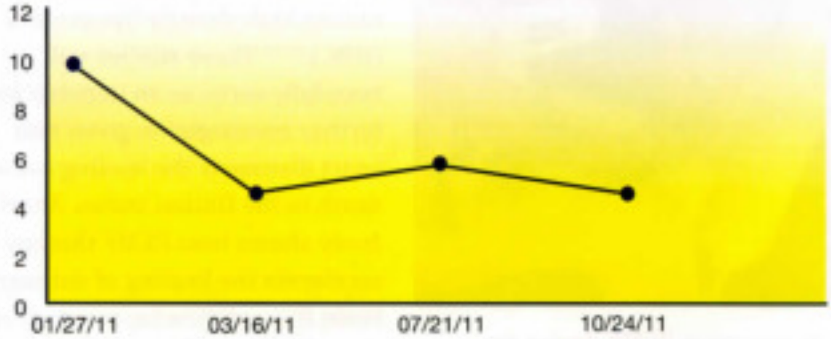


Over the short term, clinicians can use urine deoxypyridinoline (uDPD) levels to monitor response to therapy. Deoxypyridinoline cross links Type 1 collagen found in bone. In conditions where bone turnover is high, deoxypyridinoline spills into the urine in high levels. As bone turnover decreases, uDPD levels drop.

In my preliminary analyses, I find that PEMF therapy lowers uDPD in patients with osteoporosis. In one patient, uDPD decreased by 53% in two months with weekly sessions, and the reduction was sustained with once-monthly sessions. If this finding is reproducible in a double-blind, placebo-controlled clinical trial, this would affirm the ability for PEMF therapy to positively impact bone remodeling in osteoporosis.[Fig. 1]

Figure 1

Collection Date	DPD Value	nM/mM Cr	%Change
1/27/11	9.7		
03/16/11	4.5		-53.61
07/21/11	5.5		18.18
10/24/11	4.5		-18.18



*DPD level adjusted by Creatinine value of 5.4 nM/L

Conclusion

As Abraham Liboff, Ph.D. has so aptly stated "... it is possible to view the living system as an electromagnetic entity, with the response of the system to a given electric or magnetic signal as an outcome expected on the basis of physical law." PEMF therapy has scientifically documented beneficial effects on multiple biological tissues ranging from bone to brain. The reason for these beneficial effects is because PEMF therapy triggers a cascade of biological processes that supports ailing tissues. Before any chemical or physiologic response is elicited in a biological system, there is always an exchange of energy. The use of specific pulsed electromagnetic frequencies prompts this therapeutic exchange of energy in a safe and cost-effective manner.

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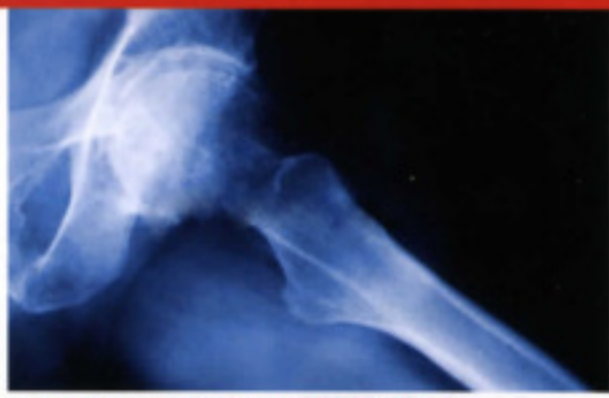

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