

Pulsed Electromagnetic Field for Lyme Disease and Chronic Infections

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Current Research on Pulsed Electromagnetic Field

Pulsed Electromagnetic Field (PEMF) has become a popular therapy for many chronic disorders. PEMF accesses biological system through electromagnetic frequencies, which is totally different from conventional chemistry-based methodology. This article is trying to review recent clinical and laboratory research on PEMF and discuss its clinical application and its potential to treat Lyme disease and chronic infections.

PEMF delivers electromagnetic signals to the body stimulating cellular functions. It has been commonly used in the field of orthopedics for the treatment of non-union fractures and failed fusions [1-4]. Laboratory research indicated that PEMF suppresses bone loss [5] through promoting TGF-beta1 and inhibiting IL-6 [6], promoting tissue regeneration [7], enhancing early cell proliferation in osteogenesis [8], and signaling osteogenic differentiation and mineralization [9]. PEMF has also been reported to help osteoarthritis [10] and proposed to be a viable alternative therapy for the disease [11]. Animal research indicated that PEMF had significant efficacy in reducing cartilage damage for osteoarthritis [12], helped healing of the cartilage defect [13], and had positive effect on viability of human chondrocytes in vitro [14].

In addition to its effect on orthopedics, PEMF has also been reported to accelerate wound healing for both animal [15, 16] and human [17], and regenerate nerve tissue [18-20]. It helps to reduce post operational pain [21, 22], chronic musculoskeletal pain [23], pain from carpal tunnel syndrome [24] and diabetic polyneuropathy [19]. It may improve function, pain and fatigue from fibromyalgia [25], help patients with treatment-resistant depression [26], and reduce symptoms from multiple sclerosis [27]. The possible mechanisms for tissue regeneration and pain management has been suggested as provoking a decrease in the production of inflammatory-type cytokines (IL-1 beta and TNF-alpha) and an increase in cytokines of lymphocytic origin (IL-10) [28].

Because of its safe nature, PEMF has a long history of clinical practice. The most controversial figure in PEMF practice is an American named Royal Rife. He believed that each microorganism has its own Mortal Oscillatory Rate (MOR). In early 1930s he published his research and claimed that his Rife Machine, a PEMF device, destroyed microbial with specific electromagnetic frequencies and helped various cancer patients through inactivating the pathogenic virus called BX factor [29]. Although up till now Rife's research has not been reproduced, some recent publications have suggested that Rife's claim may not be entirely impossible. Food industry uses pulsed-electric field to control microbial growth and preserve apple juice [30-32], grape juice [33], wine [34], milk [35] and beer [36]. It suggests that pulsed-electric field inactivate yeast and bacteria including *Lactobacillus diolivorans* [31], *Pediococcus parvulus* [31], *Salmonella enterica* [32], *Bacillus cereus* [35], *Dekkera anomala*, *Dekkera bruxellen-*

sis, *Lactobacillus hilgardii*, *Lactobacillus plantarum* [34], *Kloeckera apiculata*, *Saccharomyces cerevisiae* and *Gluconobacter oxydans* [33]. Although the frequency, intensity and delivery method of the treatment in food industry is different from those used by Rife, the nature of the treatment, pulsed electromagnetic field, remains the same. It is likely to develop therapeutic devices to resolve bacteria, virus, yeast and parasite infections in human body. Most cancer research using PEMF have been done using cancer cell lines. It suggests that PEMF induce apoptosis of melanoma [37], colon carcinoma [38], liver cancer [39] and ovarian carcinoma cell lines [40]. Although the mechanism suggested by above cancer research is different from what Rife proposed, it is still promising to see positive response from cancer cell line research with PEMF. More clinical research is needed to explore this area.

Lyme Disease and Chronic Infections

Lyme disease is the most common tick-borne bacterial infection in temperate areas of the northern hemisphere. The bacteria are called *Borrelia burgdorferi*. Recently the reported incidence of Lyme disease has increased markedly in many countries [41]. Approximately 20,000 cases of Lyme disease are reported annually in the United States alone [42]. Typical Lyme disease may have three stages: 1) early localized infection with erythema migrans (a characteristic skin rash that looks like a bull's-eye), fever, feeling unwell, fatigue, headache, muscle pain and joint pain; 2) early disseminated infection (occurring days to weeks later) with neurological, musculoskeletal, or cardiovascular symptoms; and 3) late disseminated infection with intermittent swelling and pain of one or more joints, neuropathy or encephalopathy [42]. There is evidence that oral antibiotic doxycycline helps *Borrelia* infection [42]. However, some Lyme patients have been reported to be antibiotic resistant [43]. More and more of these patients have been diagnosed as chronic Lyme disease. Patients with chronic Lyme disease are those who have the Lyme symptoms but lack of the initial stage of infection with *Borrelia burgdorferi*, or those who have been previously treated for Lyme disease but had continuing or relapsing nonspecific symptoms such as fatigue, musculoskeletal pain and cognitive complaints. The latter group should be classified as Post-Lyme disease Syndrome (PLS) [44] and antibiotic has been reported to have no impact on this group of patients [45-48].

Typical PLS contains persistent fatigue, musculoskeletal pain and neurocognitive impairment, which are also shown from other commonly diagnosed chronic diseases such as multiple sclerosis (MS), fibromyalgia and chronic fatigue. It suggested that fibromyalgia and chronic fatigue is probably induced by Lyme disease and should be classified into PLS instead [49]. MS is another commonly diagnosed neurological autoimmune condition. Studies suggested that viral infection especially Epstein-Barr infection [50, 51], a common co-infection of Lyme disease, and bacteria infection especially *Borrelia burgdorferi*

infection [52, 53], may play a role in etiology of MS. Laboratory study demonstrated that PLS serum antibody binds cells in the central and peripheral nervous systems and an autoimmune response in PLS has been suggested [54]. It indicated that MS and PLS may have similar etiopathogenesis.

Because of the difficulties to treat chronic Lyme disease and PLS, complementary and alternative medical therapies such as herbal medicine and nutritional supplements have been widely used to treat this condition [55]. Many clinicians who specialize in Lyme disease reported success in treating Lyme disease with alternative therapies such as PEMF [56]. With its effect on tissue regeneration, pain relief, anti-inflammation and anti-microbial, PEMF has potential to become an effective therapy for Lyme disease, MS, fibromyalgia, chronic fatigue, arthritis and many other chronic conditions.

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