



# **P** **M F** **THERAPY SOLUTIONS**

**PEMF** has proven to improve various physiologic functions and many conditions or disease states. Here are some of the highlights, although this is not an exhaustive list.

**DISCLAIMER:** PEMF is not a cure for any of the conditions listed below, nor are we claiming such. The information below is a summary of the literature on PEMF.

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# CONTENTS

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## Physiologic Effects of PEMF

Decreased Inflammation	4
Optimizes Nitric Oxide Production	4
Improved Blood Flow and Circulation	4
Improved Tissue Repair	4
Muscle Relaxation	5
Improved Immune Function	5
Increase Cell Membrane Permeability	5
Improves Mitochondrial Function	5
Increase in Antioxidants	6
Reduce Oxidative Stress	6
Improved Cartilage production	6
Cellular Proliferation and DNA Synthesis	6
Apoptosis	7
Stem Cells	7
Neovascularization	7
Nerve Regeneration	7

## Conditions Improved with PEMF

Arthritis	8
Degenerative Joint Disease (DJD)	8
Tendonitis/Carpal Tunnel	8
Pain Reduction	8
Oncology/Cancer	9
Migraines	9

# CONTENTS

---

BPH	9
Diabetic Retinopathy	9
Stroke	10
Alzheimers/Dementia	10
Depression	10
Insomnia	10
Nonalcoholic Fatty Liver Disease	10
Ununited Fractures	10
Chronic Low Back Pain/Non-specific Low Back Pain	10
Tennis Elbow ( lateral epicondylitis)	10
Osteoporosis	11
Rheumatoid Arthritis	11
Sciatica	11
Bone Remodeling	11
Analgesic Use	11
Herniated Disk	11
Mobility and Function	11
Overactive Bladder Syndrome	11
Post Operative Recovery	12
Non Healing Wounds	12
Lumbar Fusion	12
REFERENCES	13

# PHYSIOLOGIC EFFECTS OF PEMF

Decreased Inflammation	Optimizes Nitric Oxide Production	Improved Blood Flow and Circulation	Improved Tissue Repair
<ul style="list-style-type: none"> <li>▶ Inflammation is a main cause of chronic conditions due to an impairment of oxygenation of cells.</li> <li>▶ Protect tissue from the high inflammatory cytokine environment<sup>1</sup></li> <li>▶ Reduce some of the most well-known pro-inflammatory cytokines such as tumor necrosis factor-<math>\alpha</math> (TNF-<math>\alpha</math>), interleukin (IL)-1<math>\beta</math>, IL-6, and IL-8 release<sup>2</sup></li> <li>▶ Increase A2A and A3 adenosine receptor expression, contributing to suppression of pro-inflammatory cytokine release, such as TNF<math>\alpha</math> and IL-1, which are harmful to cartilage homeostasis<sup>4,5</sup>.</li> <li>▶ Stimulate matrix synthesis and, at the same time, suppress inflammatory cytokines<sup>6</sup>.</li> <li>▶ Bring the inflammatory milieu back to homeostasis<sup>7</sup></li> <li>▶ Decrease in TNF-<math>\alpha</math>, a proinflammatory cytokine involved in systemic inflammation, produced mainly by activated macrophages. In activated MSCs, cytokine IL-3 and IL-4 results showed a stabilization of these signaling molecules after cells were exposed to PEMF<sup>8</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Nitric Oxide (NO) acts to open up blood vessels and improve circulation.</li> <li>▶ Modulate the release of NO from eNOS and potentially affect the entire tissue repair pathway, from pain and edema to angiogenesis, bone and tissue regeneration, and other regenerative actions<sup>9</sup></li> <li>▶ Increase the rate of Ca<sup>2+</sup> binding to CaM, which then catalyzes cNOS (eg., eNOS), producing an immediate (within seconds) production of NO.<sup>9</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Improved Circulation decreases inflammation and Oxidative Stress thus harmful free radical production.</li> <li>▶ Immediate increase in vascular flow, enhancing circulation<sup>9</sup></li> <li>▶ Improved circulation and oxygenation<sup>9</sup></li> <li>▶ Increases circulation by restoring normal Ca<sup>2+</sup> ion flux and Na<sup>+</sup>/K<sup>+</sup> balance<sup>10</sup></li> <li>▶ Thirty minutes of treatment induced an increase in microvascular blood flow and tissue oxygenation that persisted for at least 3 hours.<sup>11</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Improved Tissue Repair means faster healing and recovery time.</li> <li>▶ Regulates immune cell signaling mechanisms to promote tissue regeneration<sup>8</sup></li> <li>▶ Treatment for inflammatory regulation to be used to promote tissue regeneration<sup>8</sup></li> <li>▶ 59% increase in the tensile strength of the treated wound and a 69% increase in the tensile strength of the tendon<sup>9</sup></li> </ul>

# PHYSIOLOGIC EFFECTS OF PEMF

Muscle Relaxation	Improved Immune Function	Increase Cell Membrane Permeability	Improves Mitochondrial Function
<ul style="list-style-type: none"> <li>▶ Improved Circulation helps to relax muscles and decreases lactic acid buildup.</li> <li>▶ Increased flow of ions that promote relaxation such as Calcium<sup>10</sup></li> <li>▶ Reduces the physiological deficits associated with Delayed Onset Muscle Soreness<sup>12</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Poor regulation of inflammatory/immune function can allow acute-phase inflammatory response to become chronic, initiating disease and inhibiting tissue regeneration.</li> <li>▶ Achieving homeostasis in the face of acute inflammatory/immune challenges in the human body involves maintaining a balance of highly complex biochemical and cellular interactions. When this delicate balance is upset, acute inflammatory and immune responses designed to quickly eliminate a transient threat become chronic, and inflammatory and/or autoimmune disease sets in..PEMF has the potential to regulate this very delicate balance.<sup>8</sup></li> <li>▶ By restoring normal Ca<sup>2+</sup> ion flux and Na<sup>+</sup>/K<sup>+</sup> balance, the cell can begin the process of down-regulating inflammatory cytokines<sup>7</sup></li> <li>▶ Nitric Oxide production is increased<sup>9</sup></li> <li>▶ Mechanically stimulates lymphatic drainage and blood flow<sup>9</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Increasing cell membrane permeability means the cells can breathe better, they can take in oxygen easier, and push toxins out more efficiently. This also means medicines are more bioavailable.</li> <li>▶ Increases the TMP and ion flow across the cell membrane by Stimulating the Na<sup>+</sup>/K<sup>+</sup> pump and taking Na<sup>+</sup> out with K<sup>+</sup> into the cell<sup>7</sup></li> <li>▶ Cellular electrical properties such as membrane surface charge and membrane potential can be readily influenced<sup>7</sup></li> <li>▶ Temporarily hyperpolarize and depolarize the membrane thus increasing cellular oxygenation and nutrition Increased cell membrane permeability allows better oxygen and nutrient uptake by the cells and increased toxins release from the cells<sup>7</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Cells function and create energy more efficiently, less prone to diseases and malfunction.</li> <li>▶ Enhanced brain mitochondrial function by 50-150% across six established measures, being greatest in cognitively-important brain areas<sup>13</sup></li> </ul>

# PHYSIOLOGIC EFFECTS OF PEMF

Increase in Antioxidants	Reduce Oxidative Stress	Improved Cartilage production	Cellular Proliferation and DNA Synthesis
<ul style="list-style-type: none"> <li>▶ Antioxidants help to stabilize free radicals. Free radicals cause early cell death, and lead to early aging with chronic diseases such as cancer.</li> <li>▶ Increase in antioxidant enzymes activity; CAT, SOD (SOD1 and SOD2), and glutathione peroxidase (GPx1 and GPx4)<sup>14</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ When your cells are not receiving enough Oxygen (inflammation) Oxidative Stress occurs and free radicals are produced.</li> <li>▶ Decreased the level of parameters of oxidative stress<sup>14</sup></li> <li>▶ Act on radical production and in medium with oxygen also to radical oxygen species (ROS)<sup>15</sup></li> <li>▶ Protect the liver from oxidative stress injury by decreasing MDA and GSSG level, promoting reduced GSH level, and increasing GSH-Px activity and expression<sup>16</sup></li> <li>▶ Modulate defenses against Reactive Oxygen Species<sup>17</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Cartilage allows your joints to move smoother, and act as a cushion at the ends of your bones where they connect to joints.</li> <li>▶ Increased the synthesis of the major component of cartilage matrix, known as proteoglycans<sup>18</sup></li> <li>▶ Stimulate proliferation of healthy human chondrocytes<sup>19</sup></li> <li>▶ Enhance IGF-1 expression, which participates in chondrocyte metabolism<sup>20</sup></li> <li>▶ Collagen is increased: 3 weeks of 2 h per day PEMF therapy increased the expression of GAG and Coll II<sup>21</sup></li> <li>▶ Helps to downregulate MMP13 expression of knee joint cartilage<sup>22</sup></li> <li>▶ Increase production of collagen, the major differentiated function of fibroblasts<sup>23</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ DNA Synthesis is the most essential part for biological inheritance. Cellular proliferation is the creation of new cells, essential to life.</li> <li>▶ Stimulate cellular proliferation and DNA synthesis through opening of voltage-sensitive calcium channels<sup>24</sup></li> </ul>

# PHYSIOLOGIC EFFECTS OF PEMF

Apoptosis	Stem Cells	Neovascularization	Nerve Regeneration
<ul style="list-style-type: none"><li>▶ Programmed cell death (apoptosis) occurs naturally, and is a function of the body to guard against malfunctioning cells. However, this can also occur due to free radicals running rampant. When this occurs, necrosis follows if left unchecked, and diseases such as cancer.</li><li>▶ Suppress cartilage degeneration via the inhibition of chondrocyte apoptosis by increasing the expression of anti-apoptotic proteins<sup>20</sup></li><li>▶ Affects induction of apoptosis<sup>25</sup></li><li>▶ Decreases the elevated levels of ER chaperons Grp94, PDI and the apoptosis marker CHOP in human liver carcinoma cell lines<sup>28</sup></li><li>▶ Decrease of measured cell death parameters (early and late apoptosis as well as necrosis)<sup>9</sup></li></ul>	<ul style="list-style-type: none"><li>▶ Stem Cells serve as a repair system for the body.</li><li>▶ Increase the beneficial effect of chondrogenic differentiation from stem cells<sup>20</sup></li><li>▶ Important role in promoting the osteogenic differentiation of human bone marrow stem cells (BMSCs)<sup>26</sup></li></ul>	<ul style="list-style-type: none"><li>▶ Formation of new blood vessels.</li><li>▶ Significantly increased neovascularization<sup>9</sup></li><li>▶ Positive and restorative effect on proangiogenic molecules such as VEGF<sup>10</sup></li></ul>	<ul style="list-style-type: none"><li>▶ Regrowth of nerve fibers (axons) is essential to repair and functional recovery of the spinal cord.</li><li>▶ Reduced nerve growth factor-like activity and levels (in doing so), may act on brain derived neurotrophic factor, ciliary neurotrophic factor, insulin-like growth factor, fibroblast growth factor, and gli-derived neurotrophic factor<sup>27</sup></li></ul>

# CONDITIONS IMPROVED WITH PEMF

Arthritis	Degenerative Joint Disease (DJD)	Tendonitis/Carpal Tunnel	Pain Reduction
<ul style="list-style-type: none"> <li>▶ Not only alleviates the pain in the arthritis condition but it also affords chondroprotection, exerts anti-inflammatory action and helps in bone remodeling and this could be developed as a viable alternative for arthritis therapy<sup>30</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Improve clinical scores and function in patients with osteoarthritis of the knee and should be considered as adjuvant therapies in their management<sup>31</sup></li> <li>▶ After 1 month, PEMF induced a significant reduction in VAS pain and WOMAC scores compared with placebo. Pain tolerance, and physical health improved in PEMF-treated patients. Twenty-six per cent of patients in the PEMF group stopped NSAID/analgesic therapy. No adverse events were detected<sup>32</sup></li> <li>▶ Improve bone and cartilage turnover in an animal model of OA<sup>33</sup></li> <li>▶ Data strongly support the clinical use of PEMFs in OA patients<sup>34</sup></li> <li>▶ Increased the Osteoarthritis chondrocytes<sup>35</sup></li> <li>▶ A two sample Student's t-test comparing change in knee-related pain, stiffness, and physical function for PEMF-treated leg vs control leg showed a significant difference in favor of PEMF therapy<sup>36</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ <b>Carpal Tunnel</b> - Reduction in pain, improvement in the electrophysiological studies, and hand grip strength. There are no reported side effects, discomforts, or known health risks<sup>37</sup></li> <li>▶ There was objective improvement in nerve conduction, and subjective improvement on examination, and pain scores<sup>38</sup></li> <li>▶ <b>Tendonitis</b> - Enhance Ca(2+ binding in the growth factor cascades involved in tissue healing, achieved a marked increase of tensile strength<sup>9</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ <b>Neck Pain</b> - pain severity declined by the end of the first day and continued to decline throughout the seven days of treatment; over the entire week, pain levels were lower than in the sham group<sup>39</sup></li> <li>▶ Safe for domiciliary use and this study suggests that PEMT has a beneficial effect in the management of the acute whiplash injury<sup>74</sup></li> <li>▶ <b>Post Operative Pain</b> : Associated with trends for a reduction in pain, compared to sham treatment<sup>40</sup></li> <li>▶ Effective for pain management in both simple and complex surgeries<sup>41</sup></li> <li>▶ Considerable and statistically significant potential for reducing pain in cases of lumbar radiculopathy and the whiplash syndrome<sup>42</sup></li> <li>▶ Pain had decreased in the active cohort by nearly a factor of three times that for the sham cohort<sup>9</sup></li> </ul>



# CONDITIONS IMPROVED WITH PEMF

Oncology/Cancer	Migraines	BPH	Diabetic Retinopathy
<ul style="list-style-type: none"> <li>▶ Inhibit cancer growth<sup>43</sup></li> <li>▶ Inhibit angiogenesis in tumor tissues, suppressing tumor vascularization and reducing tumor growth<sup>43</sup></li> <li>▶ Increase in tumor necrosis factor alpha levels that induce an anti-tumoral response<sup>43</sup></li> <li>▶ Slower tumor growth rate if compared with untreated control group<sup>44</sup></li> <li>▶ Increased Drug Uptake (2 Fold) to Tumor Cells<sup>45</sup></li> <li>▶ Increase effectiveness of treatments for Cancer when PEMF is used at the same time drugs are administered<sup>45</sup></li> <li>▶ Daily PEMF was found to retard angiogenesis and growth of a human breast cancer xenograph causing the tumor to develop proportionately larger areas of necrosis and hypoxia and smaller areas of proliferatively active cancer cells<sup>46</sup></li> <li>▶ In combination with Gamma Irradiation, there were significantly fewer lung metastatic sites and slower tumor growth than did untreated mice<sup>47</sup></li> <li>▶ Exhibited a potentiation of the antitumor effect of mitomycin C<sup>48</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Significant improvement in the days and duration of headaches, work-loss hours and number of medications<sup>49</sup></li> <li>▶ Exposure of the inner thighs to pulsing electromagnetic fields for at least 3 weeks is an effective, short-term intervention for migraine<sup>50</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Reduce Prostate Volume after 28 days of therapy. Symptoms improved in a short time, with high compliance and no effects on hormonal and sexual function or any side effects<sup>51</sup></li> <li>▶ PEMF and exercise therapy is beneficial in the treatment of BPH<sup>52</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Patients were treated over a 6 week period. 76% of the patients had a reduction in the level of numbness and tingling<sup>53</sup></li> </ul>

# CONDITIONS IMPROVED WITH PEMF

Stroke	Alzheimers/Dementia	Depression	Insomnia
<ul style="list-style-type: none"> <li>▶ Protective effect of PEMFs on hypoxia damage in neuron-like cells which suggest a potential therapeutic approach in cerebral ischemic conditions<sup>2</sup></li> <li>▶ Improves motor condition as well as mental efficiency. PEMF significantly boosts the effectiveness of rehabilitation<sup>14</sup></li> <li>▶ Reduced ischemic neuronal damage in the most anterior coronal level by 69% and by 43% in the striatum. Implications for the treatment of acute stroke<sup>54</sup></li> <li>▶ Effective treatment for patients after traumatic or ischemic brain injury<sup>55</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Long-term exposure to high frequency electromagnetic field treatment not only prevents or reverses cognitive impairment in Alzheimer's transgenic mice, but also improves memory in normal mice. This could have profound value in the disease's prevention and treatment through intervention at the mitochondrial level<sup>56</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Improve effectiveness of anti-depressants<sup>57</sup></li> <li>▶ Showed a clinically and statistically significant better outcome than patients treated with sham T-PEMF, with an onset of action within the first weeks of therapy. Effect size on the Hamilton 17-item Depression Rating Scale was .62(95% confidence interval .21-1.02). Treatment-emergent side effects were few and mild<sup>57</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Seventy percent of the patients given active treatment experienced substantial or even complete relief of their Insomnia complaints<sup>58</sup></li> </ul>
Chronic Low Back Pain / Non-specific Low Back Pain	Tennis Elbow ( lateral epicondylitis)	Ununited Fractures	Nonalcoholic Fatty Liver Disease
<ul style="list-style-type: none"> <li>▶ Decreased the level of pain and improved the function in subjects<sup>61</sup></li> <li>▶ Safe and effective in improving function in patients with non-specific LBP.<sup>62</sup></li> <li>▶ Adding pulsed electromagnetic field to Conventional physical therapy Protocol yields superior clinical improvement in pain, functional disability, and lumbar ROM in patients with non-specific low back pain<sup>63</sup></li> <li>▶ Decrease pain, LBP disability, increase lumbar spine mobility, and improve HRQOL in middle-aged university's employees with nonspecific LBP<sup>63</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Pain during exercise and when bending the wrist was significantly reduced. The study results confirmed that pulsed magnetic therapy quickly reduces pain caused by so-called golf or tennis elbow.<sup>64</sup></li> <li>▶ Effective in decreasing pain and improving function in participants with LE.<sup>65</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ More successful than noninvasive traditional management and at least as effective as surgical therapies<sup>59</sup></li> <li>▶ Treat patients suffering from delayed fracture healing and non-unions<sup>60</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Increase antioxidant enzymes activity and alleviate lipid accumulation in fatty liver<sup>16</sup></li> </ul>

# CONDITIONS IMPROVED WITH PEMF

Osteoporosis	Rheumatoid Arthritis	Sciatica	Bone Remodeling
<ul style="list-style-type: none"> <li>▶ Prevent bone loss and improve lipid metabolism disorders<sup>66</sup></li> <li>▶ Stimulate osteoblastogenesis, suppress osteoclastogenesis, and influence the activity of bone marrow mesenchymal stem cells (BMSCs) and osteocytes, ultimately leading to retention of bone mass and strength<sup>60</sup></li> <li>▶ May have clinical application in the prevention and treatment of osteoporosis<sup>67</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Emerging as a novel and highly promising means of treating chronic inflammation and aberrant immunity that exists in diseases such as RA<sup>7</sup></li> <li>▶ The positive role of pulsed electromagnetic field (PEMF) therapy in rheumatoid arthritis (RA) is known. Varying effects of the therapy in alleviating the different symptomatology indicate that the rheumatoid factor (RF) is more resistant to PEMF<sup>10</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Could be considered as an effective, safe and tolerable treatment for peripheral nerve repair in clinical practice<sup>27</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Helps in bone remodeling<sup>68</sup></li> </ul>
Analgesic Use	Herniated Disk	Mobility and Function	Overactive Bladder Syndrome
<ul style="list-style-type: none"> <li>▶ The net reduction in pain on the VAS was equivalent to a low to moderate dose of opioid analgesic in PEMF-exposed patients. when an opiate such as morphine is used in combination with PEMF, the side effects of the opiate may be reduced<sup>39</sup></li> <li>▶ Analgesic use during the first 24 hours after C-section was 1.9-times lower in the active-PEMF group. The total analgesic use during the seventh post-operative days was 2.1-times lower in the active-PEMF group than in the sham group<sup>69</sup></li> <li>▶ Effective in rapidly reducing use of narcotic medications<sup>41</sup></li> <li>▶ Patient use of postoperative pain medication correspondingly also decreased nearly three times faster<sup>9</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Potential therapy to protect tissue from the high inflammatory cytokine environment during disc degeneration<sup>70</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Improved mobility, pain scores, and energy level in fibromyalgia and chronic musculoskeletal pain patients<sup>71</sup></li> <li>▶ Beneficial effects on the pain, exteroceptive sensation, range of motion, and daily functioning of patients<sup>72</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ In patients with neurogenic Overactive Bladder Syndrome induced an inhibitory effect on neurogenic detrusor overactivity<sup>73</sup></li> </ul>

# CONDITIONS IMPROVED WITH PEMF

Post Operative Recovery	Non Healing Wounds	Lumbar Fusion	
<ul style="list-style-type: none"> <li>▶ Typically used for postoperative pain management with the expectation of a significant reduction in the use of narcotics and/or non-steroidal antiinflammatory drugs, earlier hospital discharge, and/or an earlier return to function<sup>14</sup></li> <li>▶ Postoperative pain was significantly lower in all the measured periods within the early and the late postoperative periods. Fewer experienced severe postoperative pain within 24 hours postoperatively<sup>69</sup></li> <li>▶ Seven days postoperatively, patients in the active-PEMF group had better wound healing with no exudate, erythema, or edema<sup>69</sup></li> <li>▶ Effective in rapidly reducing post-operative pain.<sup>41</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ In the treatment of chronic non-healing wounds, the recommended treatment is 30 minutes twice per day until the wound is closed. Closure of chronically open wounds may be seen in 6 to 10 weeks with this treatment.<sup>9</sup></li> </ul>	<ul style="list-style-type: none"> <li>▶ Fusion succeeded in 97.6% of the PEMF group and in 52.6% of the unstimulated group. The observed agreement between clinical and radiographic outcome was 75%. The use of PEMF stimulation enhances bony bridging in lumbar spinal fusion<sup>44</sup></li> </ul>	

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