Effects of Pulsed Electromagnetic Fields (PEMFs) on Stress

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The very presence of life means that stress is also present. The recognition of and the reaction to stressors is fundamental to physical and emotional existence. Our reactions to stressors are either healthy, that is adaptive, or unhealthy, that is maladaptive. Maladaptive reactions to stress created physical and psychological damage, if either too large to withstand or too frequent to recover from. An example of an adaptive physiologic response is perspiring when the body temperature increases. This response becomes maladaptive, or harmful, when the body is not able to perspire or if the stress continues too long and bodily fluids are not replenished. Stressors may also be psychological or mental. Again, the reaction may be helpful or harmful. For most of us, the use of the term "stress" refers most often to the negative psychological or physiological responses to life's stimuli.

The original human need for a stress response was adaptive, called the "fight or flight" response[8]. Typically, this response allowed us to engage a threat, such as an attacking animal. In modern Western civilization, the most common daily stressors are minor psychological events, such as, an angry client on the telephone or the tension of driving in heavy traffic. Even these seemingly minor occurrences produce a low-level "fight or flight" reaction in the body. The cumulative or chronic occurrence of these stressors does not allow adequate or full recovery and results in many of modern civilization's health problems.

The stress response causes the brain to release chemicals that stimulate the nervous system. Adrenaline is pumped into the bloodstream along with extra sugar and fact, from body stores, for energy to fuel muscles. Mental activity is focused, some organs slow their activity, while others accelerate it, the muscles tense up, the breeding rate increases, there may be tightness in the chest and queasiness in the stomach. In a high stress state, most of these reactions will be present. In a lower stress state only one or several may be present and in varying degrees.

Many believe that a healthy human body could be able to live as long as 120 years before organs gradually slow down and stop. Stress accelerates the decline by actually damaging some organs and accelerating the wear and tear on others. It is easy to see how this chronic state of stress may accelerate aging and cause heart disease, atherosclerosis, diabetes, arthritis, fatigue, immune problems, adjustment disorders and anxiety and depression. Many physicians believe that 70 to 90 percent of the problems they treat are due to stress.

Environmental effects on the development of nervous system and endocrine responses to stress can last throughout life, and the differences in environmental experiences of each individual, partially contribute to individual differences in vulnerability to stress-induced illness. A cascade of neural processes induced by aspects of an individual's early environment may lead to lifelong individual variability and may either enhance or reduce vulnerability to damage in later life.

Some of the physiologic reactions to stress are: muscle tension, rapid heartbeat, sweaty palms, diarrhea or constipation, increased gastric acid, high blood pressure, increased ACTH, increased to drown, exaggerated mental alertness, increased blood sugar, increased fat, dry mouth, increased insulin, increased thyroid hormone and immune changes.

The physical problems that can result from stress are: insomnia, nervous irritability, headaches, Atherosclerosis, hypertension, irritable bowel, gastritis, arrhythmias, panic attacks, anxiety, depression, fatigue, substance abuse, immune deficiencies, asthma, skin problems, allergies, muscle spasms, neuralgias, vision changes, hyperventilation, dehydration, sudden cardiac death, vasospasm, increased cholesterol, increased platelets, decreased oxygen, appetite problems, accelerated auto immune problems increased actually, miscarriages decreased libido, impotence, menstrual changes, disturbed memory, among others.

Clearly not all of these problems happen to everybody under stress. They happen to varying degrees depending on genetics, environmental experiences and the level and duration of the stress. Most of us throughout our lifetimes will develop at least some of the above problems.

There are many approaches to preventing and managing stress reactions. Once a stress reaction is initiated it is difficult to turn off immediately. The reaction is immediate but the recovery takes hours to days. Since the effects of stress are cumulative, a daily routine of reducing the physiologic response becomes necessary to ward off long-term damage. One approach to reducing the physiologic response to the effects of daily stress is whole body pulsed magnetic field (PEMF) therapy.

Humans are very sensitive to magnetic fields (MFs). Physiologic changes were seen during solar storms in healthy humans, patients with cardio-vascular diseases and cosmonauts in SOYUZ spacecraft and the MIR space station[21]. They had nonspecific adaptive stress reactions, with increased cortisone secretion and activation of the sympathoadrenal system (SAS) and suppressed production of melatonin.

Much experimental evidence has been gathered to suggest that biological systems are highly sensitive to weak generated PEMFs and PEMFs have a wide range of biologic effects in almost all biologic systems. Since experiments are difficult to do in humans, much work has been done in animals. PEMF inhibited the activation of the sympathetic-adrenal system (SAS) and prevented a decrease in nonspecific resistance[26] . Plasma catecholamines, chemical messengers associated with increased sympathetic arousal, decreased through modulation of hypothalamic function and increased urine excretion of epinephrine. Long term use of weak PEMFs may be able to remodel tissues that tend to be hyper-reactive to chronic or acute stress so that over time they will be less reactive.

Stress activation of the SAS in rats changes (nor)adrenaline in the hypothalamus, adrenal glands, plasma and urine. PEMFs decrease activation of the SAS by decreasing plasma and urine catecholamines [27]. The excitability of the nervous sytem also decreases and emotional reactions accompanying stress are corrected.

Environmental stressors, such as heat or sunlight, affect cellular homeostasis[10]. Thermal stressors and electromagnetic fields (EMFs) interact to induce intracellular heat stress proteins (hsp), protective proteins in the cell. PEMFs can be used preventively prior to heat, toxicity or injury to prevent cellular harm and thus increase cellular stress resistance and reduce cellular stress responses. These proteins are induced by numerous other stimuli, including heavy metals and oxidative stress[15].

This phenomenon could be exploited as a beneficial presurgical cardiovascular treatment. This has been borne out in studies that have shown that cardiotoxic effects, such as occur during cardiac surgery, may be prevented by preconditioning with PEMFs. Stimulating the cardiac cell with PEMFs may provide for it protection from injury, including cardiac surgery or heart attack. Similarly, heat pre-treatment can result in significantly improved heart salvage following coronary artery bypass grafting[15]. Other potentially therapeutic applications include protection against viral infections, autoimmune diseases, inflammatory diseases, and to support the stress response in the elderly, by counteracting the normal loss of the stress response during aging.

Originally, PEMFs were primarily considered as activating metabolic processes in the immediate tissues exposed. However, exposure of endocrine glands and control centers of the nervous system triggered broader natural control processes of homeostasis[35]. Lower dosing of the thyroid area produced a similar response vs only stronger local area exposure, eg, the heart in ischemia. This approach promoted elimination of hemodynamic and hypoxic disorders in the heart and restored adrenal hormones. In experimental hepatitis, microwave PEMFs to the thyroid were more effective in restoring liver function than exposing the liver itself. Local exposure of adrenals in patients with rheumatoid arthritis activated production of glucocorticoids and made lymphocytes function normally. This work confirmed that an adaptation to short-term (or weak) stressor factors increases the resistivity of the organism to severe stressors, including low temperatures, physical load, ischemic heart necrosis, ionizing radiation, etc.

Stress causes a very quick and significant decrease in white blood cell counts, creating a sudden state of immune vulnerability and increases serum cortisol two to three-fold. PEMFs modulate host resistance[12] by also enhancing some immune functions. Neutrophils increase gradually and neutrophil metabolsim and superoxide production are increased significantly. The cortisone level decreases. PEMF also improves host immunologic defense and splenic cell counts in mice[13], indicating a protective effect.

Ascorbic acid (AA) is key to the antioxidant, neuroendocrine and immune mechanisms of stress adaptation[34]. PEMFs cause AA and serotonin (S) to increase nearly 2-fold by the 30th day of exposure. By the 90th day, AA concentration recovered to the initial (pre-exposure) value, while S content still remained significantly increased.

PEMF effects were evaluated in athletes[4]. Decimeter wave therapy (DMW) of adrenal, thyroid gland, or collar areas favorably affect immune status and production of hormones, specifically, T-lymphocytes, testosterone and growth hormone, and decrease circulating B-lymphocytes, cortisol and decreased the initially elevated levels of thyroid hormones. The benefits were therefore high resistance to diseases and a high working capacity.

In some animal species, such as rabbits, emotional stress increases lethality. PEMFs increase resistance of the rabbits to stress: lethality was lowered by 1.9 times[7].

Pain is a major stressor. Pain inhibition (i.e. analgesia) is consistently affected by exposure to PEMFs in various species of animals, including: land snails, laboratory mice, deer mice, pigeons, as well as humans[20].

Use of PEMFs on acupuncture points produces anti-stress benefits[16]. PEMFs act like electroacupuncture (EA). The stress responses induced by painful tooth pulp stimulation in rats was reduced by electroacupuncture (EA) [11]. Nor/epinephrine, dopamine, ACTH, and cortisone all decreased. Stress-induced elevation of blood pressure was not seen when EA was used. Millimeter wave (MMW) exposure of an acupuncture point affects heart rate and heart rate variability and lability of central nervous system (CNS) processes[16]. Test subjects had increased lability of central nervous system (CNS) before and after physical exercise. In people with parasympathetic predominance, exercise increased both heart rate and its variability. With sympathetic predominance, individual reactions to exercise varied greatly. MMWs helped recovery of the heart rhythm after exercise in parasympathetic toned individuals, but not consistently in sympathetic predominance.

Stress induces neuronal atrophy and death in the brain, especially in the hippocampus. Alterations in the expression of neurotrophic factors are implicated in stress-induced hippocampal degeneration[33]. EA stimulation significantly restored neurotrophic factors.

One group studied the effects of PEMFs and constant magnetic fields[3]. Weak PEMFs were antitumorigenic, protective (in relation to toxic agents and Xray radiation), and produced rejuvenation effects in cases where there was a state of stress.

Stress in rats can lead to breakdown of elastin and collagen fibers in serum, heart muscle, cerebral cortex and liver[29]. PEMFs modulated elastase-inhibitory activity in all tissues with exposures to frontomastoid area of the head or paravertebrally, alone or incombination with laser, infrared exposure or static magnetic field (SMF). High laser strength and the combination of laser with SMF decreased the stress reaction. The use of the combination of infrared laser + SMF + PEMF had a stress-limiting effect and enhanced elastase-inhibitory activity.

Heart rate variability (HRV) results from a complex interplay of neural and hormonal control mechanisms. Changes in HRV has been associated with increased risk of severe arrhythmia and sudden cardiac death in patients with recent myocardial infarction. Human volunteers had their heart rate variability tested with PEMF exposures[22]. Heart-rates were slowed. Sinusoidal continuous waveform seemed to be more effective at producing this effect than intermittent or square-wave current waveforms. Some individuals may be more sensitive to or alternately more consistent in producing these field-induced changes in HR and HRV than others. This effect apperas to be a modulation of the threshold properties of the cardiac pacemaker, the Sino-Atrial Node, giving rise to greater beat-to-beat variability. In another series of double-blind studies it was also found that PEMFs altered the normal variability inherent in human cardiac rhythm[24,25]. Intermittent exposure (as opposed to intermittent waves) is more effective than continuous exposure.

Millimeter waves (MMW) increase resistance and ameliorate stress in animals[14]. When healthy 20 to 24 yr old humans had MMWs applied to the outer hand, improved heart rate variability (HRV). MMWs prevented or reduced stress related heart rate changes. Stress-induced EEG changes were suppression of alpha rhythm, increased theta, and other decreases in bioelectric activity. EEG rhythms with MMW treatment were the opposite. In another study of MMW exposure[28] all stressed animals had precipitous decreases of non-specific resistance, activation of lipid peroxidation. Normal control animals exposed to MMWs showed a 10-15% increase in neutrophil metabolism and increased thalamic and hypothalamic thiol exchange. The abnormal changes in stressed animals were reversed by MMW.

Static magnetic fields (SMFs) act on rabbit sinocarotid baroreceptors by reducing blood pressure by vasodilation and heart rate[6]. The effects were attributed to changes in cell membrane calcium ion (Ca++) transport since they were abolished by treatment with verapamil, a potent Ca++ channel blocker. A more pronounced effect occurs with stronger fields. The stimulated baroreceptors reset sympathetic tone. In humans, SMFs over the right and left carotid sinuses, also improved HRV vs shams and controls[5]. The effects were of minimal clinical significance in healthy subjects but could be very significant in individuals with cardiovascular disease with abnormal HRV. In other work, strong SMFs induced a vagotonic state[18].

Application of the PEMF signal resulted in the several apparently related long-lasting localized effects being observed in certain tissues: an increase in blood volume, an increase in oxygen partial pressure (PO2), persistent increases in pH (reduced acidity), increase in respiration amplitude, decrease in heart rate and changes in blood pressure[30]. The magnitude of these effects in the human subjects showed significant inter-individual variability. The effects were observed to be modulated by changes in the level of blood acidity, as indicated by measurements of lactic acid and pyruvic acid concentration, carbon dioxide partial pressure (pCO2), and hydrogen ion (H+) concentration. This meant that the PEMF effects would be increased during periods of high muscle activity, after drinking alcohol, while sleeping, or after inhaling CO2. Conditions that promoted alkalosis such as hyperventilation and eating large meals could be expected to reduce the magnitude of the effects.

Extremely low-frequency (ELF) pulsed magnetic fields (PMFs) affect blood vessels. Head and thorax exposure to ELF PMFs induced dilation of the larger blood vessels in these areas and increased oxygen partial pressure[31]. PMFs having a variety of pulse shapes, amplitudes, and repetition rates that were applied to the neck of human volunteers showed that these stimuli could alter the respiration cycle, heart rate, blood pressure, and vessel perfusion. Although these effects showed wide variability and poor reproducibility, they were, nonetheless, attributed to a decrease in central nervous system (CNS) activity and a local increase in sympathetic activity.

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