Pulsed Electromagnetic Field Therapy: Past, Present and Future

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History of Magnetic Healing

Healing therapies employing magnetic fields have been in existence for thousands of years. In ancient times, lodestones, naturally magnetized rocks, were used for their various beneficial properties. It is said that Cleopatra wore a lodestone on her forehead to enhance her skin and youthful, natural beauty. Other civilizations have been credited with using magnets to treat a variety of disorders including eye diseases, headaches and mental depression (Brewer, 2002). Early Chinese writings describe the application of lodestones to acupuncture sites in an attempt to balance the body's energy (Becker & Selden, 1985). The sixteenth century Swiss alchemist, Paracelsus used magnets to cure illness and mend broken bones (Cameron, 1983; Macklis, 1993).

By the seventeenth century, there were discoveries related to electricity that continued on into the eighteenth century, and in the nineteenth century, Michael Faraday, an English scientist, discovered that a changing magnetic field causes an electrical current. This is called electromagnetic induction. At the most basic level, all living tissue is composed of atoms with positively charged protons, negatively charged electrons, and neutrons which are neither positive nor negative. In essence, we are electrical beings. Faraday's discovery explains how changing or pulsing electromagnetic fields outside the body can influence electrical currents within the body (Ross & Harrison, 2013). When a pulsing electromagnetic field comes near living tissue, that field penetrates unobstructed through tissue and generates electrical currents within. There is no need for wires or electrodes and no physical contact between the magnet

and the body. Because there is no current flowing into the body, there is no associated pain with PEMF.

Fractures

Research by Fukada and Yasuda (1957) demonstrated the piezoelectric property of bone. When bone is stressed, electric voltage is produced. When this occurs, electric dipoles are created which attract osteoblasts, the cells that build bone, increasing bone density. Conversely, when bone is exposed to a pulsing electromagnetic field, micro currents are generated inside the bone which ultimately results in new bone formation. Their research supported the theory that living bone would develop callus through the application of pulsed electromagnetic fields (Shamos, Levine & Shamos, 1963). Over the next two decades, the use of electromagnetic field therapy quickly spread from Japan, across the former Soviet Union and into Eastern Europe. In fact, electromagnetic field therapy was commonplace across Europe in the years spanning 1960 to 1985 (Markov, 2007). In 1974, the research team of Bassett, Pawluk and Pilla demonstrated for the first time that the introduction of a low frequency, low intensity, external pulsing electromagnetic field would accelerate bone repair, and in 1979 the FDA approved the use of PEMF for non-union of fractures.

Tissue Healing and Pain Relief

Over the next ten years, PEMF became more commonly accepted as an adjunct to pain relief from inflammation, as after an injury, and also for incisional pain after a surgical procedure. Cell signaling is a process of communication that coordinates cell activities. This coordination is critical to proper functioning of cells, activation of the immune system and tissue repair. Pulsed electromagnetic fields have been shown to influence the intracellular environment and cell to cell signaling. One of the key molecules that PEMF modulates is nitric oxide. Nitric oxide

is known for its vasodilatory and angiogenic effects whereby blood vessels relax and open and new vessel growth is initiated (Pilla, n.d.). Research also suggests that the activation of nitric oxide plays an important role in the proliferation of chondrocytes, the cells found in connective tissue and cartilage (Fitzsimmons, Gordon, Kronberg, Ganey & Pilla, 2008; Li & Dong, 2016). When a pulsed electromagnetic field is introduced to an area of injury or pain, production of pro-inflammatory mediators are reduced and angiogenic and chondrogenic growth factors are increased. This can affect the entire tissue repair pathway and result in less inflammation and pain, relaxation of vascular smooth muscle, and increased blood vessel formation which helps to provide the cells with much needed nutrients and oxygen, resulting in improved tissue repair and healing (Costin, Birlea & Norris, 2012).

Urinary Incontinence

In 2000 the FDA approved PEMF for use in the treatment of urinary incontinence. This novel conservative approach to the treatment of urinary incontinence delivered a pulsed electromagnetic field that penetrated the pelvic floor, inducing a nerve impulse that prompted contractions of the muscles of the pelvic floor. When the magnet was switched off, the muscles relaxed. This forced, passive exercise of the pelvic floor muscles served to build endurance and strengthen the muscles supporting the bladder during times of physical stress such as coughing, laughing or running (Davis, 2014).

Mental Depression

In 2013, the FDA approved transcranial magnetic stimulation for the treatment of severe mental depression that is unresponsive to antidepressant medications. It is believed that major depression results from a lack of communication between the frontal lobe or dorsolateral prefrontal cortex and a deeper brain structure called the anterior cingulate cortex. The

electromagnetic field stimulates and helps to establish links between these brain structures (Baeken, C. et al., 2009). Repetitive transcranial magnetic stimulation (rTMS), has been shown to provide rapid onset of mood elevation in persons with depression and it has become widely accepted by psychiatrists with an estimated 500 or more transcranial magnetic stimulator devices in use across the United States (Shafi, Stern & Pascual-Leone, 2014).

Veterinary

Today perhaps the most widespread use of PEMF is in veterinary practices around the world. Veterinarians have long recognized the benefits that PEMF offers animals, especially racing horses and dogs that have sustained sprains, ligament injuries and fractures. Animal studies have shown PEMF to be effective in accelerating bone formation following fractures (Price, 2014), as well as promoting wound healing and augmenting analgesia following surgery in dogs (Hellyer, et al., 2000).

Safety

Research has shown that the use of PEMF is a safe, effective, and non-invasive method that can ease pain and inflammation at the site of injury. Although there is no evidence that PEMF can damage DNA or act as a carcinogen, patients who are being treated for cancers should be warned to avoid PEMF therapy. Patients who are pregnant, or who have implanted pump devices or pacemakers should also avoid PEMF therapy. However, of the hundreds of studies that have used PEMF technology, no severe adverse responses have been reported. There is a small percentage of people who have electrical or electromagnetic hypersensitivity. They may experience mild and temporary discomfort when they first begin treatments, but these sensations are usually attributed to sudden increases in circulation or stimulation of nerve cells, and are short lived, with no lasting adverse effect.

Acceptance by the Medical Community

Medicine, as it is practiced in North America, is evidence based and centered on traditional treatments and medications. Because there is no structured education for medical doctors with regard to complementary and alternative medicine, which includes PEMF, most physicians are unfamiliar with the technology and are reluctant to recommend PEMF for their patients. Perhaps another reason that PEMF has not become mainstream is due to the fact that there is a lack of standardized protocols. One only needs to look at the literature to see that there is an infinite range of frequencies and intensities, pulse widths and amplitudes, as well as number and durations of treatments. In addition, there is no consistency in distance from the magnet to the intended site of action on the body (Pickering & Scammell, 2002). Changing one single variable can alter the physiologic response making reproducible outcomes extremely difficult. Do we really know if a certain treatment plan is best for a given condition or are we operating in the dark? Fortunately, advances in the field of molecular imaging is helping us to understand how PEMF affects the body on a cellular level and can, in time, help researchers lock onto the optimal treatment parameters for various health problems (Shupak, 2003). In a healthcare environment where evidence based practice is essential, standardization of PEMF protocols is necessary if this therapy is to be accepted and its use heralded by the medical community.

The Oska Pulse

In spite of offering a safe, painless, non-invasive solution for so many problems, this technology has not been fully embraced in the west. To date, most PEMF devices are marketed as non-prescription wellness devices found in chiropractors' offices, physical therapy clinics or holistic, integrative medicine settings used primarily in the management of musculoskeletal pain. Until recently, PEMF equipment has been expensive, large and cumbersome, and out of

reach for the average person. An innovative company, Oska, Inc. (oskawellness.com) is changing this paradigm. They have created a safe, FDA listed, small, portable, and affordable device called the Oska Pulse that provides a specific sequence of pulsed electromagnetic fields over a thirty minute period. The engineers at Oska Wellness have chosen an intensity and combination of frequencies that have been shown to promote tissue repair and recovery as well as block pain. Easy to apply, the Oska Pulse comes with elastic and Velcro bands that can be wrapped around the arm, leg or torso to deliver painless, non-invasive pulsed electromagnetic field therapy to any area of the body. With Oska Pulse, there are no wires, electrodes or gels. It is a self-contained unit, and no additional items ever need to be purchased, making this a highly affordable and effective pain relief device. A small pilot study using the Oska Pulse revealed statistically significant improvement in mobility and reduction in pain and for subjects after a four week trial (Davis, 2017).

In Conclusion

The use of pulsed electromagnetic fields is safe and effective as a treatment for a variety of health issues. It has been successfully used to heal fractures, alleviate mental depression, strengthen pelvic floor muscles, and ease chronic pain and inflammation that is such a common problem in today's society. With more and more people seeking non-pharmacological alternatives that are safe and effective, pulsed electromagnetic field therapy holds great promise. As there is better understanding of the physiological response to PEMF, new applications will be discovered, and continued research will lead toward standardization of treatments and greater acceptance by the medical community.

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