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Trigger points and systemic effect for EMF therapy

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Abstract The use of magnetic fields (MFs), in general, and electromagnetic fields (EMFs), in specific, as therapeutic modalities is becoming very common. In the USA, EMFs are mostly used in orthopedics, followed by pain relief and the wound-healing arena. Even though a substantial literature exists worldwide, we are still lacking the accepted comprehensive mechanism(s) of action. In general, it is thought that the best therapeutic effects are achieved when the stimulation is applied directly to the target area. Since the beginning of this century, however, more and more evidence has been collected indicating that effects of the MF stimulation may also be observed at site(s) different from the site of application of the signal. A primary purpose of this paper is to propose a link between the systemic and direct effects. The functional units known as trigger points are discussed as possible "doors" allowing the stimulation to be delivered to the target tissue/organ. A second purpose is to suggest some possible modes of action.

Keywords Magnetic fields · Systemic effects · Trigger points

1 Brief background

Humans have known for centuries that some magnetic materials could have plausible effects when applied for treatment of various health problems. Probably, the first written document for therapeutic use of magnets is the book "De Magnete", written in 1600 by British natural philosopher William Gilbert. For centuries, China, Japan, and India developed "natural medicine" that utilized the unusual properties of natural and artificial magnets. The contemporary history of magnetic field (MF) therapy began after the end of the World War II in Japan and spread over Europe. By the middle 1980s, nearly all European countries had developed and manufactured their own magnetotherapeutic systems mostly utilizing time varying low frequency magnetic/electromagnetic fields (EMFs).

In the United States, near the end of the twentieth Century, encouraging signs appeared on the horizon, in regard to the interest in alternative and complimentary medicine, including bioelectromagnetics and magnetotherapy. The National Institutes of Health convened several meetings on Complementary and Alternative Medicine, which included a meeting of the committee on bioelectromagnetics. This committee evaluated the science of bioelectromagnetics and its potential therapeutic value, and the findings and recommendations of this committee are found in their report. (Rubik et al. 1995) At the time of the "Rubik report," both static and time varying MFs had been successfully applied to therapeutically resistant problems in the musculoskeletal system (Bassett 1989, 1994; Pilla and Markov 1994; Markov 1995; Shupak 2003; Rosch and Markov 2004). The most effective clinical applications of these physical factors were related to bone unification as well as reduction of pain and edema in soft tissues. For musculoskeletal injuries and post-surgical, post-traumatic, and chronic wounds, MFs are recognized as a modality that enhances healing and contributes to the reduction of edema. It is well known that edema reduction can be a major therapeutic modality in accelerating the relief of pain

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and stress. Surprisingly, edema reduction has been reported with low MF amplitude (in the range of 1–50 mT), frequency (in the range of 1–100 Hz), and with pulsed radiofrequency signals set at 27.12 MHz when applied to sites of injury/pain (Markov and Pilla 1995).

Perhaps, more than ever, it now seems clear that MFs interact with biological tissues in ways that specific physiological changes are observed. Further, it is accepted that EMFs provide a practical exogenous method for inducing cell and tissue modifications that can alter selected pathological states, with little to no known side effects. A number of books and review papers have been published on MF therapy (Bassett 1989, 1994; Itoh et al. 1991; Pilla and Markov 1994; Markov 1995; Markov and Pilla 1995; Shupak 2003; Rosch and Markov 2004; Barnes and Greenebaum 2007). In spite of the reported worldwide success in clinical application of MF, MF therapy has limited acceptance in medicine in Western hemisphere. As has already been pointed out (Markov 2007):

- Medical practitioners are unprepared to utilize magnetotherapy
- Regulatory activity is unnecessarily restrictive
- Public concerns about safety of MFs are sensationalized in news media

Scientists and clinicians are, to a great extent, guilty for the negative attitude of main stream medicine. In a recent review of 56 clinical trials using MFs, only two papers reported satisfactorily the type of MFs, the protocol, and execution of their study (Colbert et al. 2007).

Without going into details of magnetotherapeutic applications and mechanisms of action, we bring to the readers' attention two distinct hypotheses developed by us—trigger points' contribution to the delivery of MF/EMF to the targets and systemic effects as a mean of transmission of the signals.

2 Trigger points as a "Door" to the body

Trigger points as functional units may refer pain to immediate local areas or to areas quite distant from where they are located (Travell and Simons 1983). These trigger points appear to serve as a conduit wherein MFs may enter the body. These units appear also to be interactive with peripheral nerves. For example, application of selected MFs to one arm could result in clearly identifiable response in the contralateral limb, as occurs in a segmental reflex (electrical conduction crossing through the spinal cord to the opposite side) at same level of the spinal cord. Both the segmental reflex and the pain relief at a distance through the trigger point are considered as a demonstration of a systemic effect.

Elaborating a little more beyond what has been said above, comments should be in order to explain how we came to focus on trigger points. One of us (CFH) has placed magnets on his body seeking pain relief. In summarizing this experience, it was found that placement of the magnet on the site of the pain experience led to some relief, but never considered satisfactory. Upon seeing a photocopy of a figure in a pain clinic, which schematically showed a trigger point at the mid-thigh area near the groin referring pain to the right knee cap, the idea surfaced that one might possibly be able to "enter the body magnetically" at the site of the trigger point (Travell and Simons 1983, see vol 2, p. 250, Fig. 14.1). If that were the case, would pain relief be experienced? The procedure was completed within 1.5 h, the patellar pain (chronic for CFH) completely dissipated.

This experience was shared with Dr. Vallbona who had a clinic for polio survivors. Indeed, myofascial pain abounds in this population. Soon, more elaborate experimental designs were considered, and a proposal was sent to an institutional review board (IRB), approved, and executed. A uniqueness of the study was that the treatment involved placing the magnets on the trigger points referring the pain rather than on the pain experience per se (Vallbona et al. 1997; Hazlewood 2003; Hazlewood and Markov 2006).

As to the definition of trigger points and how they may be studied, we rely mainly on the work of Travell and Simons (1983), who synthesized some 30 years of work in their book *Myofascial Pain and Dysfunction* the *Trigger Point Manual*. This book has become a hallmark in myofascial pain, and, in these two volumes, they have not only summarized a wealth of information but also provided an "atlas" as to where the various trigger points are most likely to be found along with their associated fields of referred pain. This two volume book is strongly recommended for any one serious about pain in general and myofascial pain in particular.

In past experience, the use of permanent magnets placed immediately over the trigger points reduced or eliminated the pain referred from the activated trigger point. Often, the pain field is distant to the trigger point, which is not anatomically connected. Thus, the possibility of a need to explain a second phenomenon emerges—"action at a distance." Travell and Simons (1983) defined trigger points as "A focus of hyperirritability in a tissue that, when compressed, is locally tender and, if sufficiently hypersensitive, gives rise to referred pain and tenderness…." It should be added that trigger points are not anatomical structures, but, rather, a functional entity. The identification of trigger points with their referred pain experience is relatively easy with the Trigger Point Manual. Often, in the area where a trigger point is thought to exist, there is a gradual onset of sensitivity and this is referred to as a latent trigger point. Please note that an active myofascial trigger point is always associated with pain, whereas inactive and latent trigger points are not. Even though the inactive and latent trigger points are difficult to identify, it is now known that they are associated with limitations of motion and weakness. The latent trigger point may persist for years after partial recovery from injury has begun. Acute attacks of pain may be intermittent and present over long periods of time. Overstretching, overuse, or cooling of the muscle may serve to reactivate it. In summary, both latent and active trigger points cause dysfunction and active trigger points cause pain. Finally, it should be recognized that myofascial trigger points are to be distinguished from those of other tissues, such as skin, ligaments and periosteum. Once, knowledge of the referred pain by trigger points had become clear in our minds, an assumption was made that MFs, applied to trigger points, would reduce or abolish the pain referred by the specific trigger point. The first test of this hypothesis was initiated in a pilot study of a small population of subjects with a chronic pain condition known as the post-polio syndrome. In this clinical setting, the trigger points and their sites of referred pain were well delineated (Vallbona et al. 1997).

2.1 MF for treatment of post-polio syndrome

Overuse (perhaps awkward use) of body parts is perhaps the largest cause of myofascial type pain. The magnitude of the population experiencing myofascial type pain is unknown; however, one well-known group within the broad group of disabilities is the survivors of polio—a condition referred to as post-polio syndrome (PPS). For example, in the case of post-polio syndrome, years of using crutches, limping, or awkward compensation to overcome the physical defects of the disorder activate abundant trigger points. In regard to numbers, one of the latest estimates of the size of the population of polio survivors is set at one million (Elrod et al. 2005). The types of pain experiences in this group are multiple, including a lot of diffuse muscle and joint pain (Smith and Mabry 1995). The joint pain is thought to be due to degenerative arthritis secondary to aging. Sub acute or chronic sacroiliitis occurs very often, but many times it is not recognized because other forms of low back pain mask it.

A double-blind, randomized clinical trial was conducted in post-polio patients to determine whether pain was relieved by application of static MFs applied directly over an identified trigger point (Vallbona et al. 1997). The devices used in this study were Bioflex magnets that have a pattern of concentrically arranged circles of alternating magnet polarity. Placebo devices were of identical sizes and shapes. Fifty post-polio patients with muscular or arthritic pain participated in this study. Twenty-nine patients were randomly selected to receive treatment with the active magnetized device, while twenty-one patients were exposed to the inactive device. Only one area of pain was evaluated, even though multiple sites may have been present. A trigger point associated with the site of pain was grossly elicited first by finger palpation and then by firm application of a blunt object, which in non-painful areas produced a sensation of pressure but no pain.

After removal of the device, the patient was asked to assess the intensity of pain again using the McGill Pain Questionnaire. The proportion of patients in the active-device group who reported a pain score decrease greater than the average placebo effect was 76%, compared with 19% in the placebo-device group (Vallbona et al. 1997).

2.2 Systemic effects

A second goal of this paper is to focus on the search for a new model capable of explaining some effects of MF/EMF therapy on humans in a clinical setting. The proposed hypothesis for systemic effects is based upon the understanding that the functions of most, if not all, systems in human body are driven by electric potentials and currents. For example, firing of neurons is basically transmission of electric signals, the blood flow is associated with movement of charged particles, any transport phenomena depends on electric charges and potentials. In addition, the direct interactions of the EMF with all the components within the circulation are expected to lead to effects at a distance (i.e., a systemic effect). Therefore, an appropriate choice of MFs/EMFs would initiate changes at the systemic level, which will be manifested at points distant to the place of application. In such cases, the systemic effect may play a role in reducing inflammation, and should be connected with both blood vessel and lymphatic systems (Markov et al. 2004).

2.3 The use of MFs in the case of chronic low back pain

A large body of scientific literature suggests that magnetic therapy may have utility in the treatment of pain (Trock et al. 1993a, b, 1994; Markov and Pilla 1995; Vallbona et al. 1997; Sartucci et al. 1997; Shupak 2003; Markov 2004a) pain represents an important health problem in which medical costs and lost work capacity are major issues. Disorders of the low back are a major cause of disability of people under the age of 45. In fact, medical costs associated with the treatment of low back disorders have been estimated to fluctuate between $4.6 and $60 billion annually in the US Static and time-varying EMF have been applied with apparent success in the management of pain in a variety of orthopedic conditions, most commonly traumatic bone fractures or surgical osteotomies (Bassett 1989, 1994). Furthermore, in the domain of osteoarthritis several double-blind, placebo-controlled studies demonstrated the efficacy of pulsed EMFs for the relief of pain (Trock et al. 1993a, b, 1994). However, it should be noted that despite a number of clinical studies performed world-wide indicating successful use of MFs for treatment of various diseases and pathologies, little is known regarding the effectiveness of MFs in relieving low back pain. Harden et al. (2007) recently published a double-blind study on using therapeutic electromagnetic field device (TEMF) for treatment of low back pain. This signal applied a rectified, semi-sine wave signal over the low back painful area. Significant improvement of the victims of pain was reported when the signal amplitude was 15 mT, and the effect is larger than at both 10 and 20 mT. This confirmed the hypotheses of 15 mT biological window (Markov 2004b). The study demonstrated a general improvement of the patient's status that could be attributed to involvement of musculoskeletal-spinal cord system in healing. It might be speculated that the treatment influences not only the cause of the pain, but also brings about a general relaxation, achieved as a result of effects on neuronal and vascular systems. It may be important at this place to mention the pioneering work of Nordenstrum, who, in 1983, proposed the theory of closed biological electrical circuits that involve several body systems in response to the applied EMF. Remarkable results have been obtained in using this plausible hypothesis in treatment of various types of cancer.

2.4 Magnetic fields, sports injuries and the possibility of systemic effect

The successful MF/EMF treatment of chronic injuries and pain was demonstrated in the previous section. There are, however, conditions for which successful treatments have yet to be established. MF/EMF modalities are now widely used in sports medicine for diagnostics and treatment of acute pain and trauma. In all the subjects evaluated with sports injuries, the early treatment of any soft tissue trauma with MFs is of great significance. We have both anecdotal and systematic evidence that various MFs and EMFs have been successfully used in treatment of acute traumas in different sports. The first to be mentioned is a low frequency, low intensity EMF, applied by the German National soccer team beginning early 1970s. Pulsed radiofrequency signals were found beneficial for practicing pitchers, by extending their pitching time by 30% with comfort, and without injury. The same sofPulse signal reduced the absence of injured hockey players from the ice by 50%. It has already been shown that the THERAMAG™ signal is beneficial in treatment of acute and sub-acute injuries that occur during professional football (Ericsson et al. 2004). Early treatment of the acute and sub-acute injuries was shown to forestall and reduce chronic conditions for which there is little effective therapy. In some cases of sports initiated trauma, the MF/EMF treatment is impossible to be directly applied to the site of injury. Nevertheless, magnetic stimulation was proven to be effective. If these observations happened to be correct, two conclusions could be drawn: (a) The systemic effect might be the reason for faster recovery of the athletes; (b) MF treatment has beneficial effects at treatment of the acute and chronic pain and trauma.

2.5 Reflex sympathetic dystrophy

One of the more striking demonstrations of systemic effects caused by selected EMF is found in the significant benefit exhibited by the victims of reflex sympathetic dystrophy (RSD). Following results with a number of isolated RSD patients, a protocol of study was prepared and submitted for IRB consideration. The proposal was approved and is currently open. In general, patients need to meet the criteria of reflex sympathetic dystrophy. Pain proximal to the involved extremity is permitted as inclusion; however, general myofascial pain syndromes (in which patients have pain over much of their body) are excluded (Hazlewood 2003). Following clinical evaluation and signing a consent form, each patient ranks their pain on a visual analog scale (VAS), and the hand and forearm of the uninvolved limb placed in an electromagnetic device, the THERAMAG™, for 1 h. After conclusion of this therapy, each patient is evaluated for relief of pain and a second VAS is recorded. The initial report of this study included publications by Ericsson et al. (2004), and the findings since that report are continuing along the same line: the VAS decreases from around 8 to 9 before treatment to less than two after treatment. Clinical evaluation consistently reveals an improvement in muscle strength, reduction in edema, and a reduction in flexion contractures in the most severe cases of RSD.

Several interesting clinical observations are worth noting: (1) Within 15–20 min, marked redness appears on the extremity not placed in the THERAMAG™ device (indicating that the cross reflex is activated during the treatment); (2) Each patient experiences a slight euphoria followed by drowsiness during the hour exposure to the MF; (3) There was a detectable, but slight, drop in postural (standing) blood pressure following conclusion of therapy that lasts from 30 to 60 s; and (4) Approximately 60% of the patients experience slight chest discomfort during the course of the therapy.

In a recent use of MFs, a very interesting observation was made. When a subject reported for treatment of pain associated with RSD. Following our previous experience that RSD pain could be treated in accordance of the systemic effect model, the subject was exposed to EMFs via a THERAMAG™ device over the left arm while the severe pain was experienced in the right knee. After 60 min exposure to pulsating EMF, the subject's pain was significantly reduced. (Incidentally, it was found that another type of pain existed in the same leg referred to as irritation, and this was the most bothersome pain.) A careful examination indicated the existence of a trigger point in the area identified by Travell and Simons (1983; see p. 251, Fig. 14.2A in vol 2). A small 900G neodymium magnet was applied for 2 h to the trigger point and the subject reported significant reduction in pain to a tolerable level. This combination of pulsating and static MFs allowed the subject to stop using her pain medication.

The above case study is an indication that, depending on the etiology, and location of the painful area both pulsating EMF and carefully selected (by field strength) permanent magnet(s) might be beneficial in treatment of pain. One may conclude that the systemic effect as initiated by THERAMAG™ pulsating EMF and the trigger points approach might cause significant pain relief. This is even more encouraging in the sense of the possible combination of both approaches, especially when the pain victims can not routinely use systemic effect therapy by electromagnetic devices, but may utilize the trigger point approach.

It should also be noted that application of the EMF directly to the involved limb (e.g., the wrist, following surgery) induced pain relief and enhanced healing. Further, in summary, it should be remembered that pain relief may be observed in that part of the body where the EMF is applied, in areas of the body on the same side of the application, on the opposite side, or even in the neck, face, and head. In the use of the electromagnetic device (THERAMAG™), exposure of one arm to the EMF leads to visible physiological changes in the contralateral hand and arm. Also, pain in the feet may be relieved as well. Such observations indicate the existence of action at a distance or a systemic effect. Using a device similar to THERAMAG™, pain relief for low back pain has been reported (Harden et al. 2007).

2.6 The immune system as target for EMFs

The response of an organism to exogenous factors, including various MFs, involves circulatory, neuronal, endocrine, and immune systems. While the nervous and endocrine systems are involved in information transfer and in the coordination of various body functions, the immune system serves as a guardian against any intruder, including any internal violation of basic functions. In addition, the immune system participates in autoimmune and allergic diseases. We are mostly interested in the response of the immune system to exogenous EMF because the immune system actively participates in repelling invaders and fighting against agents that might cause inflammation and pathology. In other words, the immune system is seeking all means available to the organism in order to maintain homeostasis. When, for whatever reason, the homeostatic changes overcome the control of the regulatory systems, the organism moves to a state out of equilibrium (Lushnikov et al. 2002).

Currently, most therapies aim to bring the organism back to equilibrium by pharmaceutical means. However, stimulating the immune system with pharmaceutics often causes adverse effects. Following the "pharmaceutics" terminology, one of us introduced the term "electroceutics" to define the therapeutic use of EMFs (Markov 1999). The major advantage of electroceutics compared with pharmaceutics is the potential for fewer side effects. The challenge of electroceutics will be to apply EMF signals with the appropriate intensity, frequency, and waveform to target the desired tissue. Analyzing the existing knowledge on EMF interactions with immune system, we emphasize the following: (1) Pathologies and injuries most often involve inflammation, (2) What, if not the immune system, fights inflammation? (3) Why is the immune system involved? (4) Are the EMF interactions with immune system local or systemic? We have already pointed out that in most cases the therapeutic effect of EMF is a systemic effect (Markov et al. 2004, 2005). Lushnikov et al. (2002) provided evidence for systemic effects observed with studying the effects of millimeter (MM) waves on immune system. EMFs are shown that they may enhance immune response as evidenced by increased antibody levels, faster maturation of B lymphocytes, and enhanced delayed hypersensitivity reactions.

There is no single cell in our body that does not function by moving ions and charged particles across the cytoplasm and membranes. This creates currents and fields within and around cells. Given, these EMFs are very small, but small fields can sum within tissues dependent on the state of the organism. It is likely that different scenarios exist in healthy and diseased tissues, or in growing and aged tissues, when exogenous EMFs can perturbate the endogenous EMF. It has been pointed out that the therapeutic MFs, as most physical modalities, are more effective in treatment of biological systems out of equilibrium (Markov 2004a).

Nindl et al. (2002) showed that the effects of the two distinctly different EMFs (power frequency EMFs and pulsed therapeutic EMFs) on Jurkat cell DNA synthesis were similar. While the cells in early and late log phase growth were relatively insensitive to EMFs, cells in mid-log phase were most susceptible to EMF exposure. EMFs caused a significant 30–50% growth inhibition in actively signaling cells. Jurkat cells react to EMF stimulation with cell cycle arrest and thus behave like normal T lymphocytes stimulated by antigens at the T cell receptor. This indicates that EMFs have the ability to augment the normal intrinsic behavior of the cells (Markov et al. 2006). Another way to transfer T cells into highly EMF-sensitive metabolic states is to first activate the cells with chemical agents that cause cell signaling, leading to strong biological effects. Evidence was collected in studying the effects of 120 pps pulsating semi sinewave (EMF Therapeutics, Inc.) on normal Jurkat cells and chemically single- or dual-activated Jurkat cells.

In both studies listed above normal, chemically non-activated Jurkat cells were used as a model for normal proliferating T lymphocytes from healthy tissue. These cells circulate in lymph and blood vessels and reside in lymph tissues of a healthy body on alert to become activated when there is an injury or a pathogenic threat. Further the effect of EMFs on single activated Jurkat cells was tested as a model for spontaneously autoreactive or aberrantly activated cells in the body. It is known that when T lymphocytes are activated by a single stimulus only, they become functionally inactive for an extended period of time (anergic) and eventually undergo apoptotic death. This normal biological response limits unwanted expansion of T cells.

Inquiry was made as to whether the therapeutic EMFs could alter cell growth or apoptosis in completely activated Jurkat cells as a model for completely activated T cells from inflammatory tissue. T cells may be activated in two ways: at the level of the T cell receptor and at one additional stimulatory site. We found dual-activated Jurkat cells to be sensitive to EMF. At that time, T cells need to be eliminated to lower the total number of cells back to normal levels. This inhibition is further augmented by about 50% under the influence of EM. These results indicate that the cells' sensitivity to EMFs is highly related to their growth and signaling state. T cells isolated from rats with an inflammatory disease (Johnson and Nindl 2004) responded to EMF similarly to the dual-activated Jurkat cells modeling inflammatory T cells, with an inhibition of proliferation. On the other hand, T cells isolated from healthy rats did not respond to EMF. This response was similar to the response of normal Jurkat cells, which were not affected by EMF (Nindl et al. 2002). Extrapolating our results into a clinical setting, we hypothesize that EMF therapy is not likely to induce inflammation in healthy tissue by activating normal T lymphocytes or by interfering with normal T cell selection. On the other hand, EMFs have the ability to accelerate the elimination of inflammatory T lymphocytes, and thus the ability to prevent chronic manifestation of inflammation and to limit inflammatory side effects such as pain.

The EMFs are most effective when they are applied to cells that are already activated. The selective sensitivity of cells to EMFs seems to be crucial for the successful application of EMF in medicine. In order to obtain a better understanding of systemic effects, one needs to consider those cells that respond to EMF and the possibility that these cells serve as mediators and carriers of the modifications from the site of application to the target tissues. We hypothesize that normal homeostatically stable cells remain unaffected by EMF but the effects from EMF exposure could lead to functional and physiological changes that return tissues to normal status.

The challenge to successfully use this knowledge to implement EMF therapy is to develop new models of the interactions between EMF fields and biological material. We believe that the observation shows the stronger response when the immune cells are out of equilibrium (stimulated with chemical mitogens, or because of disease/pathology, versus cells in balance have enormous importance for the therapeutic use of EMF). If this hypothesis is correct, EMF will, in a therapeutic setting, specifically target cells that are displaced from their homeostatic norm as a consequence of disease, without compromising healthy cells/tissue.

Such a therapy will have a marked advantage over many traditional therapies in that it will cause significantly fewer side effects. Furthermore, EMF could target cells that are homeostatically unstable as a consequence of other ongoing therapy. In this scenario, EMF therapy will act as an adjuvant and augment conventional treatment modalities such as photo or radiotherapy, surgical interventions, or treatments with biologic agents such as antibodies or cytokines.

2.7 On the possible mechanism of magnetic fields effects on trigger points

As it has been already discussed, a trigger point may broadly define hyperirritable local segments of muscle including attached connective tissue. When felt/palpated it is like a knot. This "knot" is painful upon compression and evokes the characteristic referred pain. At best, the definition is operational; however, it is remarkable as to how easy it is to identify these active trigger points when the site of referred pain is known (i.e., between patients). We are suggesting that the trigger points may be nothing more than a localized contraction (i.e., involving a very small segment of the entire muscle). Further, if sustained compression, acupuncture, massage, lasers, MFs, etc., cause the contracted segment to relax, the trigger point will lose its apparent anatomical expression. (If this interpretation is correct, it offers an explanation for one of the "mysteries" of trigger points: "here today, gone tomorrow.") Now, expanding a bit on MFs, a rather strong case has been developed that only discrete MFs are therapeutically effective (Markov 1995, 2004a; Markov and Pilla 1995).

It is known that muscle function is ongoing with actin/myosin interactions. In a series of studies on the effects of various MFs performed in Markov's laboratory, it was shown that myosin phosphorylation is strongly dependent on the conformational status of the calmodulin molecule (Markov 2004b, c, d). It has been shown that selected MFs are capable of influencing the binding of calcium ions to calmodulin molecule causing conformational changes and influencing the ability of calmodulin to participate in myosin phosphorylation. Since it has been found that the same MFs that affect myosin phosphorylation are effective in reducing pain (Harden et al. 2007), we feel it reasonable to assume that pain relief may occur via conformational changes in the localized contracted segments. Thereby, the "frozen" segments may be unblocked and the trigger point would not be manifested.

We are well aware that both, the systemic effects approach and the trigger point hypotheses, represent novel interpretation of scientific and clinical observations of the effects of various MFs in the therapy of diverse medical problems, especially pain relief. If these ideas come to be correct, further theoretical and experimental studies are more than necessary.

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