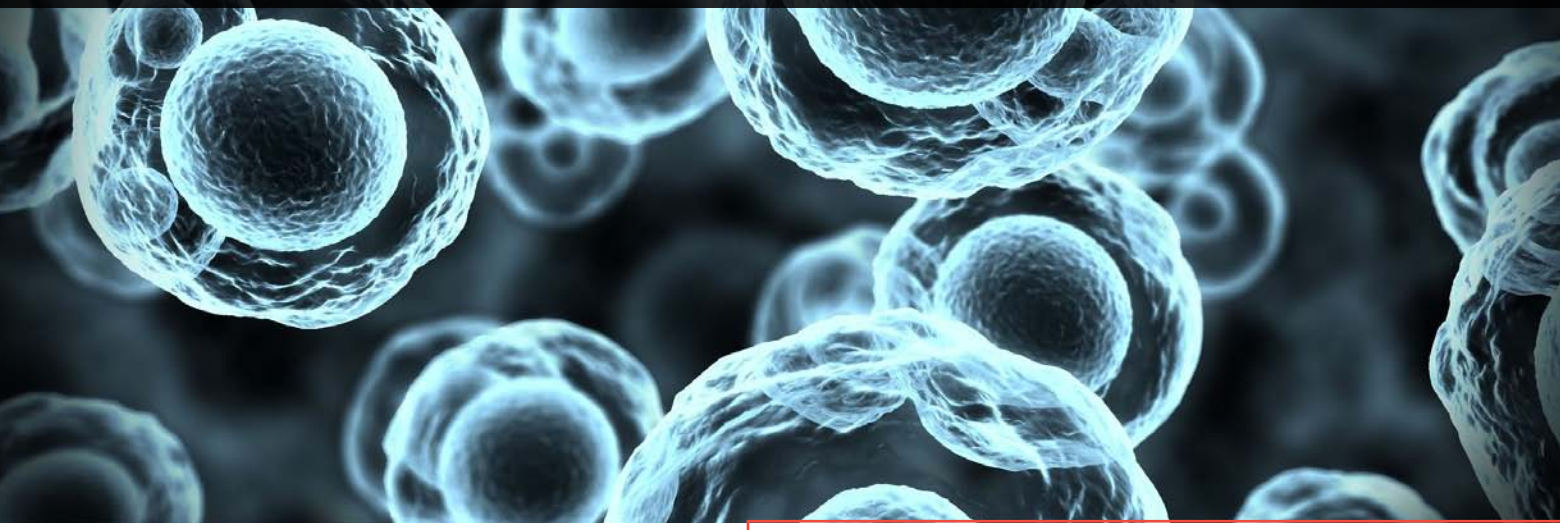
FEATURE

Quantum Theory Underpins Electromagnetic Therapies for Pain Management

Exploring the use of quantum-based energy medicine modalities for the treatment of pain in clinical practice.



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Editor's Note:
One of the most important subjects in complementary and alternative pain medicine is the administration of electrical currents and electromagnetic energy fields—including the use of laser, light, and radio waves. In this article, two researchers who have dedicated themselves to understanding why these measures help manage pain, explain the basics of physics known as "quantum theory" and explore its uses in pain medicine. We encourage Drs. Milne and Sorgnard—and others—to pursue this avenue of research.

What Is Quantum Biology?

In 1943, Erwin Schrödinger, the Nobel Laureate and founder of quantum theory, proposed that living matter at the cellular level can be thought of in terms of quantum mechanics—pure physics and chemistry.[1] Since then, biologists have struggled to understand and embrace the infinite possibilities of quantum biology.[2-10] Medical understanding of quantum mechanisms of action and/or specific quantum treatments have lagged, however, because the role of quantum physics in biology is neither well understood nor taught in medical schools.[11] In fact, it wasn't until the 1990s that researchers began to explore biology via the quantum theory.

It is easy to understand, therefore, why most physicians, with minimal exposure to the vocabulary of quantum biology, look skeptically at the vast therapeutic potential of "energy medicine" to provide real patient-centered results. At the present moment, the clinical application of innovative cellular signaling energy and combined quantum modalities provide an important contribution to the mitigation of pain.

Understanding the Terminology

We assume that life is a molecular process. Molecular processes operate according to the quantum theory; therefore, life is a quantum process. With more than 50 trillion quantum living cells, humans interact with all the other quantum fields in their environment. The word "quantum"

comes from the Latin word "quantus," which means "how much." "Quanta" is plural for quantum. Quantum is the minimum amount of any physical entity involved in an interaction. Behind this, one finds the fundamental notion that a physical property may be "quantified," and as such has certain discrete values. This is referred to as the "hypothesis of quantization." The magnitude of these values also has certain discrete values. For example, an entity, such as human nerve cells, has quantified energy transfer of a certain number of subatomic elementary particles of matter called fermions or photons.

We can also consider that a prerequisite for life is the ability to provide a steady-state condition via a flow of bioelectrical energy and chemicals. This steady-state condition maintains electrochemical imbalance across biomembranes; transduces and amplifies minute signals into definite actions; summons energy at will; and engages an extremely rapid and efficient energy transformation.[10] From the work of Pischinger[12] and recently, Pienta and Coffey,[13] we know that energy transformation is effected through a coherent cellular matrix.

"Cells and intracellular elements are capable of vibrating in a dynamic manner with complex harmonics, the frequency of which can now be measured and analyzed in a quantitative manner by Fourier analysis [and other methods]," wrote Pienta and Coffey.[13] The authors also noted that growth factors or the process of carcinogenesis can alter these vibrations. "It is important to understand the mechanism by which this vibrational information is transferred directly through the cell [and throughout the organism]. From these observations we propose that vibrational information is transferred through a tissue tensegrity matrix that acts as a coupled harmonic oscillator operating as a signal transducing system from the cell periphery to the nucleus and ultimately to the deoxyribonucleic acid [DNA]. The vibrational interactions occur through a tissue matrix system consisting of the nuclear matrix, the [microtubular] cytoskeleton, and the extracellular matrix that is poised to couple the biological oscillations of the cell from the peripheral membrane to the DNA. The tensegrity tissue matrix system allows for specific transfer of information through the cell [and throughout the organism] by direct transmission of vibrational chemomechanical energy through harmonic wave motion."[13]

Another term uncommon to pain treatment, but applicable here, is "resonance." While usually recognized as increasing sound or vibration, the term resonance also may apply to enhancing electricity or energy. Pain treatment modalities and instruments that operate on quantum theory use resonance to increase energy in and between cells. Molecular resonance is best understood with an analogy in the macroscopic world. When a piano tuner strikes a tuning fork next to the piano, the specific piano string will vibrate when it is correctly tuned to the same frequency. Similarly, cells resonate and energy transfer between molecules is a very fast process (10^{-8} to 10^{-15} seconds).[10]

We propose an encompassing model concept called "Quantum Resonance Induction" to make the point that the electric currents and electromagnetic energy fields administered for pain treatment electronically induce and amplify resonant subatomic particle movements and activity to create healing within cells.

The idea of molecules communicating and exchanging energy by electromagnetic resonance fits in with accumulating evidence that cells and organisms are liquid crystalline, that all the molecules, especially those made up of 70% water, are aligned in chaotic synchronization, working coherently together.[10] As molecules self-assemble into structures on all scales, one would not be surprised to find vibrations and resonance over the entire range of frequencies throughout the cell, and indeed throughout the whole body.[10]

Serbian researchers Veljković and Cosić essentially asked a fundamental question in biology: What is it that enabled the tens of thousands of different kinds of molecules in an organism to recognize their specific targets?[14] They proposed that molecular interactions are electrical in nature, and they take place over distances that are large compared with the size of molecules. Dr. Cosić later introduced the idea of dynamic electromagnetic field interactions—the idea that molecules recognize their particular targets and vice versa by electromagnetic resonance.[8] In other words, the molecules send out specific frequencies of electromagnetic waves, which not only enable them to "see" and "hear" each other, but also allow them to influence each other at a distance and become ineluctably drawn to each other if vibrating out of phase (in a complementary way).

Dr. Cosić studied how charges moving to the excited protein or nucleic acid sugar-phosphate back-bone will produce electromagnetic radiation of specific frequencies corresponding to the electronic energy distribution along the chain. She repeated the procedure for many proteins with the same function and found that more than 1,000 proteins from more than 30 functional groups had been analyzed. Remarkably, the results showed that proteins with the same biological function share a single frequency peak, while there is no significant

peak in common for proteins with different functions. Furthermore, the characteristic peak frequency differs for various biological functions. The same results were obtained when regulatory DNA sequences were analyzed. Cosić referred to this phenomenon as the resonant recognition model of molecular function. The important point is that a protein or DNA sequence generally has more than one function, but it vibrates at one frequency for each function.[8] If this theory continues to develop, then one day in the future specific resonant frequencies may be supplied to living cells and tissues to induce healing.

Pain Treatment Based on Quantum Theory

Pain is the perception of discomfort at one focus or many foci in the body, and the transmission of a pain signal from the peripheral sensory receptors to the brain is a dynamic process. It has now been shown that the first nerve connection, or synapse, where the peripheral nerve meets the central nervous system in the dorsal horn, is where both pain (hyperalgesia) and pain relief (analgesia) are processed.[15] This is accomplished through the ascending stimulatory pathways and modulated by the descending inhibitory pathways. It is also through the interactions between these two pathways that acupuncture is thought to affect pain[16] via a mechanism(s) that has not yet been scientifically established.[17]

The use of electronic instrumentation has grown exponentially over the past 30 years. Many new therapeutic technologies have been developed for the diagnosis and treatment of pain, including electrotherapy,[17] transcutaneous electrical nerve stimulation (TENS) therapy,[18-20] piezoelectric therapy,[21] ultrasonic therapy,[22,23] light therapy (eg, lasers, light-emitting diodes [LEDs], laser needles),[24-27] electric cell-signaling treatment (EST),[28] and the newest combination of therapies that essentially combine several different modalities into a single clinical device (SynRG-QRSI).[28] Many of these technologies offer advantages and disadvantages. While the development of effective instrumentation that produces reliable results is very challenging, rapid progress is being made in the clinical practice of quantum-based technologies.

Some of the quantum-based energy medicine modalities are described below.

Mechanical Vibration

Mechanical vibration is the use of very fine physical oscillations to produce therapeutic benefits. Studies have shown that vibration therapy causes myriad physiologic changes in various organ systems, including the musculoskeletal, endocrine, and nervous systems. Within the musculoskeletal system, vibration has been shown to increase muscle strength and power,[29] as well as flexibility through muscle lengthening.[30] The former is thought to occur through stimulation of the "stretch reflex" (tonic vibration reflex) by vibratory amplitudes of 2 to 4 mm.[31] Vibration therapy has been shown to decrease back pain and has resulted in increased bone strength in patients with osteoporosis and osteopenia.[32-35]

Vibration therapy has also resulted in endocrine changes within the body, including up to a 460% increase in growth hormone production, up to a 7% increase in testosterone production, and a 30-fold decrease in cortisol levels.[36] This therapy can also affect the nervous system, with one study illustrating reduced tremor in conditions such as multiple sclerosis, amyotrophic lateral sclerosis, and Parkinson's disease.[37] In the authors' experiences, even microfine vibration with amplitude of approximately 0.01 mm was efficacious in providing additional pain relief without the displeasing thumping sounds that accompanied longer vibratory amplitudes.[38]

Light and Low-level Light Therapy

Light and low-level light therapy (LLLT) is painless, nontoxic, and has minimal or no side effects. One of the safest forms of light therapy uses low-level light in the form of LEDs.[39] The beneficial effects of LLLT include an increase in the body's production of adenosine triphosphate (ATP) and endorphins to reduce pain; decreased inflammation, edema, erythema, and sensations of warmth; improved lymphatic drainage; increased blood circulation (particularly to areas of trauma); an increase in the proliferation of fibroblasts and osteoblasts; and up to a 75% increase in enzymatic activity.[25] Clinical experience has shown that the use of LLLT in the form of LEDs augments pain reduction via the resonant vibration frequency of the photons. Light therapy is truly quantum based, as the photons appear to stimulate the harmonic vibration of atoms within the cells and improve intercellular communication via resonant energy transduction through microtubules and gap junctions.[40]

Acoustic Sound

Ultrasound has been used for many years both diagnostically and therapeutically.[22,23] Sound waves stimulate motion of fluids through the body and brain, bringing oxygen and other nutrients to tissues. This increases serotonin, dopamine, and other neuropeptides, which help in altering our perception of pain.[41] Additionally, there appears to be a second, less scientific understanding of the effects

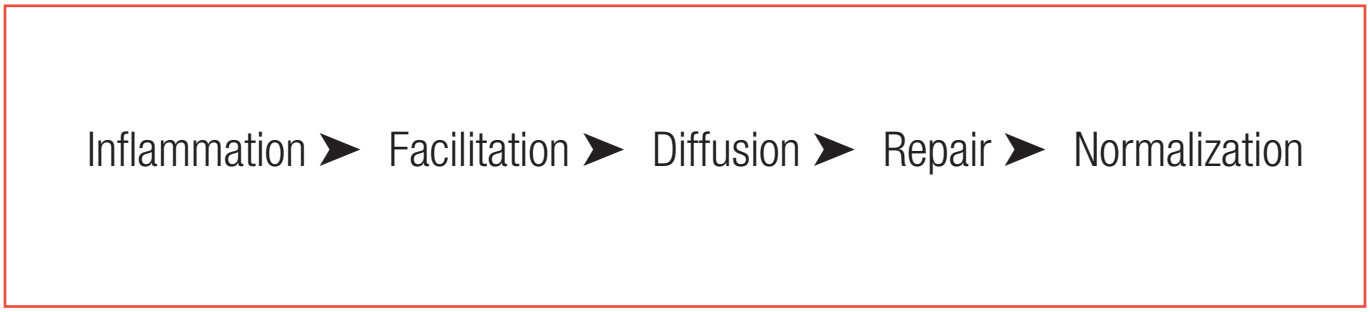

Figure 1. Inflammation cascade process.

of sound vibration on pain. Since the discovery of music, sound waves have been used as a soothing method of relaxation and there are numerous anecdotal reports of healing with sound and music. The mechanism involved in this process may be directly related to frequency resonance, as it appears that each of our various organs has their own specific frequencies at which they resonate in a healthy state.[42] A growing number of researchers feel that exposing unhealthy organs to their "healthy" resonant frequencies will assist the organs in returning to their normal state of resonance and health. By delivering specific frequencies directly through the body, an entirely different system of the body (the brain stem and spinal cord) is brought into play, offering the possibility of direct entrainment cellular stimulation.[42,43]

Magnetic Vibration

There is abundant evidence that magnetic and electric fields affect living organisms. Even the simplest life forms make use of electric and magnetic field effects, illustrated clearly in the process of signal transduction through the gated transport of sodium, potassium, calcium, and chloride ions in neurons.[44] Over the past 30 years, scientists have classified magnetic fields into two broad groups: static and time varied. Static fields are further subtyped as either permanent or direct current electromagnetic. Time-varied fields are either pulsed electrical current or radiofrequency sinusoidal fields.[45,46] Magnetic therapy, based on modest static fields produced by permanent magnets, has not sufficiently distinguished itself from a more accepted form that is based on high-pulsed magnetic fields produced by electromagnets. The actual mechanism by which electromagnetic fields produce biological effects is under intense study[35,47]; and the evidence suggests that magnets act on biological systems in multiple ways.[33,35,47-54]

The seminal work of Michael Faraday in the mid-1800s demonstrated that an imposed magnetic field actually moves electric current.[55-57] This induced energy current could be expected to transport or mobilize areas of unusually high stagnant protons in dysfunctional cells and tissues and thereby help normalize the affected tissue pH (acidosis).[58] An important aspect of magnetic fields is that they permeate all body tissues without interference. Various cell structures, including mitochondria, are stimulated by magnetic fields, and relatively small magnetic energies are required to affect chemical reactions in cells.[54]

These effects are widespread and include increases in intracellular calcium through changes in the calcium channel, changes in the sodium-potassium pump, increases in ribonucleic acid/DNA production, increases in conversion of ATP to adenosine diphosphate, and stimulation of cyclic adenosine monophosphate (cAMP).[54,59] Additionally, free radical production can be decreased significantly by magnetic fields at strengths as low as 10 to 100 gauss.[60,61] No cellular damage has been seen from even the most powerful static magnetic fields.

The extracellular fluid is very sensitive to the application of magnetic fields. The body is at least 65% fluid, which is mostly a salt, electrolyte, and ion solution. Externally applied magnetic fields will influence and charge currents, as well as the electromagnetic field states of the body's fluids.[59]

There is evidence that magnetic fields decrease vascular resistance, and increase tissue oxygen perfusion.[44,62] The effect reduces swelling and decreases clotting and platelet adhesiveness.[35] Human and animal studies have shown decreased nerve cell firing after exposure to magnetic fields, which may affect pain perception.[61,63] Studies with salamanders show that they can be put into deep sleep anesthesia using electromagnets.[61] In fact, specifically designed electromagnets are already used in nerve conduction testing and brain stimulation research.[64,65]

Magnets produce specific and direct actions on acupuncture points

and meridians[66] that are very rapid,[67] mediated by the microcurrents generated through the Faraday effect via the tendinomuscular systems that transmit electrical stimuli.[27]

Electricity

Electricity has played an integral role in the function of many of our organ systems and is routinely used in the diagnosis of heart disease and disease of the nervous system.[68] A citation in the early 1900s expounds on the benefits of electric current for "…the relief of the superimposed infiltration and chronic inflammation" for an enlarged prostate.[69] The same reference goes on to state that, "The employment of electricity is amply justified [in cases of pathologically incurable diseases] for the improvement of metabolism, the promotion of comfort, and the prolongation of life, even when no cure can be expected."[69]

It is well known and well accepted that electricity plays an important role in contemporary medicine.[70] Our largest organ, the skin, generates a voltage across itself everywhere on the body, yet the signaling function of this "skin battery" remains largely unexplored.[68] In diagnostic applications there are a number of valuable devices such as electrocardiography, electroencephalography, electromyography, nerve conduction velocity, electro-oculography, electroretinography, electronystography, electrocochleography, evoked potentials, skin galvanic/impedance tests, bioelectric field imaging (BFI), current perception threshold testing, and nerve conduction testing.

The historical development of therapeutic electrical modalities include a number of medical devices: TENS, percutaneous electrical nerve stimulators, powered muscle stimulators, interferential current devices, spinal cord stimulators, electroconvulsive therapy, high-voltage galvanic stimulators, transcranial electric stimulators, microcurrent stimulators, bone growth stimulators, deep brain probe stimulators, and most recently, EST devices.

Sensory and motor neural activities are associated with the action potential, and most biochemical interventions become electrical events. Odell and Sorgnard introduced the concept of treating inflammation with parameter-specific EST, defined as a digitally produced sinusoidal electronic signal with associated harmonics to produce necessary, desired physiological effects.[28,71] The signals are produced by advanced electronics not available even 10 years ago.

EST appears to modulate, facilitate, or accelerate the naturally occurring inflammatory process without interfering with the normal inflammatory cascade progression until the inflammation is resolved. Concomitant cellular mechanisms support the anti-inflammatory effects of EST and published literature states that inflammation leads to numerous chronic conditions, especially chronic pain. The mechanisms of action of the applied EST can be effectively used to reduce or modify the undesired symptoms normally present during this inflammation cascade process. This is illustrated in Figure 1.

There are a number of mechanisms of action described in the treatment provided by EST. These actions include an oscillo/torsional effect, pH normalization, balancing metabolic concentration differences, cAMP formation and activation (leading to the normalization of cell function), cell membrane repair and stabilization, salutary effects on metabolism, sustained depolarization of the nerve cell membrane (producing nerve block), immune system support, and the obvious macro benefits of increases in blood flow and edema reduction.[69]

The early systems, or TENS, use amplitude modulation (AM) only with frequencies at or between approximately 1 to 200 Hz. These AM frequencies tend to stimulate and cause neurons to fire. Depending on the rate of nerve impulse firing, a number of physiological mechanisms of action can occur. A simple way of thinking about the differences between EST and TENS is that EST frequency ranges tend to signal, while well-known TENS ranges tend just to stimulate.

EST electrical energy devices use either spread-spectrum frequency hopping, frequency modulation (FM), or AM combined with FM as the basis for signaling the biosystem to initiate complex biochemical responses and actions—such as hormone imitative effects, second-messenger formation (cAMP), inhibition of smooth muscle contraction, vasodilatation, membrane stabilization, and others. To accurately hypothesize or project how TENS and next-generation EST devices will affect or manipulate the naturally occurring electrical properties of the human biosystem will require additional ongoing scientific and clinical research.

Development of Combination Medical Devices

Extensive clinical research recently began examining newer electronic devices that integrate different groups of available energy sources. Quantum resonance-specific induction (QRSI) is an innovative technological device that combines the scientifically documented technologies of light, sound, electric cell signaling, magnetism, and microvibration. Then, these technologies are synergistically combined to

produce multifrequency rapid induction of synchronistic gap junction resonance. As theorized by Hameroff et al,[7] the device may normalize cellular dysfunction by enhancing cell-energy communication. In the clinical setting, rapid change in acupuncture point sensitivity and pain relief is noted for many types of pain syndromes.[28]

The next-generation prototypical device is currently under clinical investigation, referred to as SynRG-QRSI. This device combines the above technologies with EST via spread-spectrum frequency generation. Early, unpublished clinical data indicate significant promise as a rapid method of normalizing cell and tissue function, thereby providing rapid pain relief in the clinical setting. Research on the synergistic properties of mechanics, sound, light, magnetism, microvibration, and electricity theoretically produce resonance-specific induction of γ synchrony and voltage increases via gap junction quantum effects in microtubules.[7] The increased voltage in the cells improves proton motive force and enhances cell-to-cell communication with resultant rapid relief of pain. Since electrical gap junction communication is noted to be higher in the descending pain pathways,[72] the mechanism of action of these devices for pain relief may lie in the enhancement of the descending pathway's electrical function.[73]

Summary

We see future directions of research and clinical use to include the synergistic incorporation of the above technologies with recent developments in quantum physics in the realms of coupled "small-world" networks as they pertain to biological oscillators and bipolar amacrine nerve networks,[74] Josephson junction arrays, central neural networks, cellular microtubule function in energy transfer, and the use of QRSI technologies to improve proton motive force and cellular energy capacity. Uncovering the varied methods that energetically affect these networks will hopefully direct future efforts to elicit the underlying mechanistic explanation for the rapid cellular energy changes and the clinical observation of rapid mitigation of pain. ■

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Dr. Milne has disclosed that he is a stock/shareholder and patent holder for Resonant Specific Technologies, Inc.

Dr. Sorgnard has no financial information to disclose.

References

1. Schrodinger, E. What is Life? The Physical Aspect of the Living Cell. Lecture delivered at: Trinity College, Dublin, Ireland; February 1943.
2. Pribram, K. *Rethinking Neural Networks: Quantum Fields and Biological Data*. Hillsdale, NJ: Erlbaum; 1993.
3. Froelich H, Kremer F. *Coherent Excitations in Biological Systems*. Berlin, Germany: Springer-Verlag; 1983.
4. Umezawa H. *Quantum Field Theory*. Holland: North-Holland Publishing Co, 1956.
5. Vitello G, Alfinito E. Formation and life-time of memory domains in the dissipative quantum model of the brain. *Int J Mod Phys B*. 2000;14(8):853-868.
6. Popp FA. Biophotons and their regulatory role in cells. *Frontier Perspectives*. 1998;7:13-22.
7. Hameroff SR. Quantum computation in brain microtubules? The Penrose-Hameroff "Orch OR" model of consciousness. *Philosophical Transactions Royal Society London (A)*. 1998;356:1869-1896.
8. Cosić I. Macromolecular bioactivity: is it resonant interaction between macromolecules?—Theory and applications. *IEEE Trans Biomed Eng*. 1994;41(12):1101-1114.
9. Abbott D, Davies PCW, Pati AK, eds. *Quantum Aspects of Life*. London, England: Imperial College Press; 2008.
10. Ho MW. *The Rainbow and the Worm-The Physics of Organisms*. Singapore and River Edge, NJ: World Scientific; 1998.
11. Scholes GD. Quantum-coherent electronic energy transfer. Did nature think of it first? *J Phys Chem Lett*. 2010;1(1):2-8.
12. Pischinger A. *The Extracellular Matrix and Ground Regulation—Basis for a Holistic Biological Medicine*. Berkeley, CA: North Atlantic Books; 2007.
13. Pienta KJ, Coffey DS. Cellular harmonic information transfer through a tissue tensegrity-matrix system. *Med Hypotheses*. 1991 Jan;34(1):88-95.
14. Veljković V, Cosić I, Dimitrijević B, Lalović D. Is it possible to analyze DNA and protein sequences by the methods of digital signal processing? *IEEE Trans Biomed Eng*. 1985;32(5):337-41.
15. Ieran M, Zaffuto S, Bagnacani M, Annovi M, Moratti A, Cadossi R. Effect of low frequency pulsing electromagnetic fields on skin ulcers of venous origin in humans: a double-blind study. *J Orthop Res*. 1990;8(2):276-82.
16. Stux G, Promeranz B. *Acupuncture: Textbook and Atlas*. New York, NY: Springer-Verlag; 1987.
17. Trock DH, Bollet AJ, Dyer RH Jr, Fielding LP, Miner WK, Markoll R. A double-blind trial of the clinical effects of pulsed electromagnetic fields in osteoarthritis. *J Rheumatol*. 1993;20(3):456-460.
18. Burton C, Maurer D. Pain suppression by transcutaneous electrical nerve stimulation. *IEEE Tran Biomed Eng*. 1974;21(2):81-88.
19. Deyo RA, Walsh NE, Martin DC, Schoenfeld LS, Ramamurthy S. A controlled trial of transcutaneous electrical nerve stimulation (TENS) and exercise for chronic low back pain. *N Engl J Med*. 1990;322(23):1627-1634.
20. Burton C. Instrumentation for dorsal column stimulator implantation. *Surg Neurol*. 1974;2(1):39-40.
21. Shapiro DM. Piezoelectric stimulation of acupuncture points for the treatment of back and neck pain: a discussion of 3 cases. *Med Acupunct*. 2001;13(1):10-12.
22. Rapacholi MH, ed. *Essentials of Medical Ultrasound: A Practical Introduction to the Principles, Techniques and Biomedical Applications*. Totawa, NJ: Humana Press; 1982.
23. Baker KG, Robertson VJ, Duck FA. A review of

therapeutic ultrasound: biophysical effects. *Phys Ther*. 2001;81(7):1351-1358.

24. Bjordal JM, Couppé C, Chow RT, Tunér J, Ljunggren EA; A systematic review of low-level laser therapy with location-specific doses for pain from chronic joint disorders. *Aust J Physiother*. 2003;49(2):107-116.
25. Tuner J, Hode L. *The Laser Therapy Handbook: Clinical Practice and Scientific Background*. Grangesberg, Sweden: Prima Books AB; 1999:21.
26. Litscher G, Wang L, Schikora D, et al. Biological effects of painless laser needle acupuncture. *Med Acupunct*. 2004;16(1):24-29
27. Niemtzow RC. Electronic instruments and acupuncture points. *Med Acupunct*. 2001;13(1):Editorial
28. Odell RH Jr, Sorgnard RE. Anti-inflammatory effects of electronic signal treatment. *Pain Physician*. 2008;11(6);891-907.
29. Milne R. New device combines acupuncture with four other technologies to alleviate pain. *Pract Pain Manage*. 2011;11(6):94-104.
30. Bosco C, Colli R, Introini E, et al. Adaptive responses of human skeletal muscle to vibration exposure. *Clin Physiol*. 1999;19(2):183-187.
31. Luo J, M.cNamara B, Moran K. The use of vibration training to enhance muscle strength and power. *Sports Med.* 2005;35(1):23-41.
32. Bosco C, Cardinale M, Tsarpela O, Locatelli E. New trends in training science: the use of vibrations for enhancing performance. *New Stud Athlet.* 1999;14(4):55-62.
33. Rubin C, Xu G, Judex S. The anabolic activity of bone tissue, suppressed by disuse, is normalized by brief exposure to extremely low-magnitude mechanical stimuli. *FASEB J.* 2001:15(12):2225-2229.
34. Schuhfried O, Mittermaier C, Jovanovic T, Pieber K, Paternostro-Sluga T. Effects of whole-body vibration in patients with multiple sclerosis: a pilot study. *Clin Rehabil*. 2005;19:834-842.
35. Rittweger J, Just K, Kautzsch K, Reeg P, Felsenberg D. Treatment of chronic lower back pain with lumbar extension and whole-body vibration exercise: a randomized controlled trial. *Spine*. 2002;27(17):1829-1834.
36. Bosco C, Iacovelli M, Tsarpela O, et al. Hormonal responses to whole-body vibration in men. *Eur J Appl Physiol*. 2000;81(6):449-454.
37. Kapur AS, Stebbins GT, Goetz CG. Vibration therapy for Parkinson's Disease: Charcot's stuides revisited. *J Parkinsons Dis*. 2012;2:23-27.
38. Milne R. Unpublished clinical observation by author.
39. Karu TI. Low-power laser therapy. In: VoDinh T, ed. *Biomedical Photonics Handbook*. Boca Raton, FL: CRC Press; 2003:1-25.
40. Leitner DM. Quantum localization and protein-assisted vibrational energy flow in cofactors. *New J Phys*. 2010;12:085004.
41. Altman J. Information processing concerning moving sound sources in the auditory centers and its utilization by brain integrative and motor structures. In: Syka J, Masterton R, eds. *Auditory Pathway: Structure and Function*. New York, NY: Plenum Press; 1988:349-354.
42. Ellis P. Incidental music: a case study in the development of sound therapy. *Br J Mus Ed*. 1995;12(1):59-70.
43. Marwick C. Music therapies chime in with data on medical results. *JAMA*. 2000;283(6):731-733.
44. VanWijk R. Bio-photons and bio-communication. *J Sci Explor*. 2001;15(2):183-197.
45. Neumann E. Electric and magnetic field receptors. In: Meyers RA, ed. *Molecular Biology and Biotechnology: A Comprehensive Desk Reference*. New York, NY: Wiley-VCH Publishers; 1995:266-270.
46. Sisken BF, Kanje M, Lundborg G, Herbst E, Kurtz W. Stimulation of rat sciatic nerve regeneration with pulsed electromagnetic fields. *Brain Res.* 1989;485(2):309-316.
47. Chokroverty S, ed. *Magnetic Stimulation in Clinical Neurophysiology*. Stoneham, MA: Butterworth; 1990.
48. Frankel RB, Liburdy RP. Biological effects of static magnetic fields. In: Polk C, Postow E, eds. *Handbook of Biological Effects of Electromagnetic Fields*. 2nd ed. Boca Raton, FL: CRC Press; 1996:149-184.
49. Polk C, Postow E, eds. *Handbook of Biological Effects of Electromagnetic Fields*. 2nd ed. Boca Raton, FL: CRC Press; 1996:395-420.
50. Walleczek J. Magnetokinetic effects on radical pairs: a paradigm for magnetic field interactions with biologic systems at lower than thermal energy. In: Blank M, ed. *Electromagnetic Fields: Biological Interactions and Mechanisms*. Washington, DC: American Chemical Society; 1995.
51. Blank M, ed. *Electromagnetic Fields: Biological Interactions and Mechanisms*. Washington, DC: American Chemical Society; 1995.
52. Mooney Y. A randomized double-blind prospective study of the efficacy of pulsed electromagnetic fields for interbody lumbar fusions. *Spine.* 1990;15(7):708-712.
53. Bassett CA. Bioelectromagnetics in the service of medicine. In: Blank M, ed. *Electromagnetic Fields: Biological Interactions and Mechanisms*. Washington, DC: American Chemical Society; 1995.
54. McLean MJ, Holcomb RR, Wamil AW, Pickett JD, Cavopol AV. Blockade of sensory neuron action potentials by a static magnetic field in the 10mT range. *Bioelectromagnetics.* 1995;16(1):20-32.
55. Faraday M. *Experimental Researches in Electricity*. Volume 1. London, UK: Richard and John Edward Taylor/University of London; 1839.
56. Faraday M. *Experimental Researches in Electricity*. Volume 2. London, UK: Richard and John Edward Taylor/University of London; 1844.
57. Faraday M. *Experimental Researches in Electricity*. Volume 3. London, UK: Richard Taylor and William Francis/University of London; 1855.
58. Pokorný Jiří; Google Workshop on Quantum Biology Microtubules—Electric Oscillating Structures in Living Cells; October 22, 2010; ABSTRACT: Fröhlich formulated hypothesis of coherent electromagnetic activity.
59. Sullivan DR. Effect of a constant magnetic field on invertebrate neurons. In: Bamothy M, ed. *Biologic Effects of Magnetic Fields*. Vol 2. New York, NY: Plenum; 1969:243.
60. Liboff AR. Bioelectromagnetic fields and acupuncture. *J Alt Complement Med.* 1997;3(suppl 1):s77-s87.
61. Becker RO. *The Body Electric*. New York, NY: Morrow; 1985.
62. Warnke U. Infrared radiation and oxygen partial pressure in human surfacial tissue as indicators of the therapeutic effects of pulsating magnetic fields of extremely low frequency. Report from the 2nd International Congress on Magnetomedicine. *Biophys Med Rep*. 1981;2:1-8.
63. Bennett WR Jr. *Health and Low Frequency Electromagnetic Fields*. New Haven, CT: Yale University Press; 1994.
64. Weber M, ed. Therapy with pulsating magnetic fields used in combination with other treatment methods. *Biophys Med Rep*. 1992:64.
65. Pawluk W. Magnetic field therapy. In: *Novey DW. Clinician's Complete Reference to Complementary and Alternative Medicine*. Philadelphia, PA: Mosby; 2000.
66. Hsu M, Fong C. The biomagnetic effect and its application in acupuncture. *Am Acupunct*. 1978;6:289-296.
67. Reichmanis M, Marino AA, Becker RO. Electrical correlates of acupuncture points. *IEEE Trans Biomed Eng*. 1975;22:533-535.
68. Nuccitelli R, Nuccitelli P, Ramlatchan S, Sanger R, Smith PJ. Imaging the electric field associated with mouse and human skin wounds. *Wound Repair Regen*. 2008;16(3):432-441.
69. Potter SOL, Funk E. *Therapeutics, Materia Medica and Pharmacy*. Philadelphia, PA: P. Blakiston's Son & Co; 1917.
70. Woessner J. Electric Nerve Block, In: *Weiner's Pain Management: A Practical Guide for Clinicians*. Boswell M, Cole E, eds. London, UK: Taylor & Francis Group; 2006; Chapter 83:1233-1242.
71. Odell RH Jr, Sorgnard RE, May HU. Electroanalgesic nerve block. *Pract Pain Manage*. 2006;6(3):42-54.
72. Yoshimura M, Furue H. Mechanisms for the anti-nociceptive actions of the descending noradrenergic and serotonergic systems in the spinal cord. *J Pharmacol Sci*. 2006;101(2):107-117.
73. Mosekilde E, Maistrenko Postnov D. Chaotic Synchronization: Applications to Living Systems. Singapore: World Scientific; 2002:295-419.
74. Swanson LW. *Brain Architecture. 2nd* ed. New York, NY: Oxford University Press; 2012.