Mitigating Phantom-Limb Pain With Electric Cell Signaling—A Case Report

Robert H. Odell, Jr., MD, PhD
Interventional Pain Management Specialist
Las Vegas, Nevada

Richard Sorgnard, PhD
Executive Director
Morhea Technologies
Las Vegas, Nevada

Robert Milne, MD
Chief Executive Officer
Milne Medical Center
Las Vegas, Nevada

Roy M. Cary, PA-C
Physician Assistant
Las Vegas, Nevada

When a person loses a limb through a traumatic event, pain from the injury does not cease following amputation. Phantom limb pain occurs in as many as 85% of these individuals who undergo surgical amputation. Patients, at times, perceive the phantom limb as adopting a habitual position and posture; at other times, they perceive the limb as being in an abnormal position, with the entire limb or portions of it twisted out of shape, floating in space, or frozen in a fixed position. This can be extremely distressing for the patient and can cause feelings ranging from discomfort to severe pain.

It is not uncommon for a patient to feel sensations from a phantom limb all the time, but phantom limb pain often occurs intermittently several times a day. Pain felt prior to the amputation often is mimicked in the phantom limb, and the patient feels as if they are still experiencing the pain. The pain often is described as a burning, cramping, or shooting sensation that ranges from mild to severe. In addition to pain, patients feel specific sensations in the phantom limb such as touch, temperature (hot and cold), vibration, pressure, tingling, and itching.

Evolution of Phantom Limb Pain

The incidence of this chronic pain syndrome has been climbing due to injuries incurred during the Iraq and Afghanistan military conflicts. Until recently, the predominant theory for the cause of phantom limb pain was irritation in the severed nerve endings.[1] When a limb is amputated, many severed nerve endings are terminated at the remaining stump. These nerve endings can become inflamed, and were thought to send anomalous signals to the brain. These signals, being functionally nonsense, were thought to be interpreted by the brain as pain. In 1999, Melzak proposed that a pain neuromatrix is activated in specific brain regions, ultimately resulting in pain sensations independent of the sensory source of the pain.[2] With a better understanding about how acute pain becomes chronic, it now is believed that phantom limb pain is a central pain phenomenon caused by remodeling of the central nervous system (CNS), starting at the affected limb and moving throughout the entire sensory pathway all the way up to the cortex.[3] In other words, phantom pain may be a maladaptive failure of the neuromatrix to maintain global bodily constructs.[4] Research now indicates that the pathophysiology comes from changes at the dorsal horn and higher levels in the CNS.[5]

Prophylactic measures are used to try to prevent phantom limb pain from developing for elective amputations (as in diabetic patients with chronic wounds, patients with osteomyelitis, etc). However, traumatic amputations do not permit prophylactic care.

Promising New Treatment

This case report describes the use of a promising and relatively new electric cell signaling treatment device for phantom limb pain. The device uses a digitally generated, non-invasive alternating signal current, delivered by a wave generator and administered transcutaneously. The complex signal energy waveforms are formed first as electrically balanced, biphasic symmetrical sinusoidal primary waves, and then modulated by superimposed frequencies (Hz) and varying dosages (amplitude) to create complex rapidly changing signals that easily pass through dermal tissue and avoid repetitive nerve accommodation. These specific and

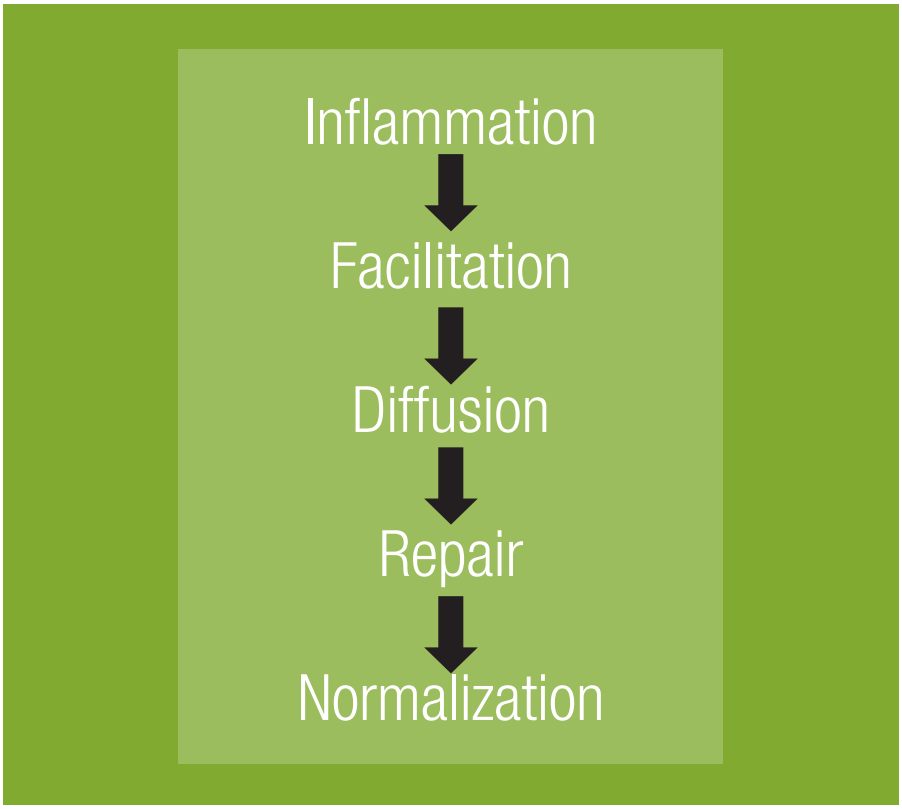

Figure 1. Inflammation cascade. One mechanism of action of the applied electronic cell signal energy accelerates the process of the inflammation cascade; this effect reduces the risk of chronic inflammation.

time-varying pulsed electric signals are introduced through the skin of injured or diseased tissue by special vasopneumatic electrodes.

The administration of these complex electrical signals is accomplished by advanced electronic signal energy microprocessors, also known as microelectric mechanical systems (MEMS), which were not available a few years ago. The term we use to describe these bioactive electric energy signals when applied to a patient is electric cell signal treatment (EST). The EST device is engineered and produced as a collaborative effort by Sanexas International GmbH (Germany); Resonant Specific Technologies, Inc. (USA); and Morhea Technologies LLC (USA), and uses an ultra-high digital frequency generator (UHdfg) system that can deliver targeted, combined frequency-modulated (FM) and amplitude-modulated (AM) electric energy signals transcutaneously into the body. The details regarding EST technology were first introduced, defined, and described in earlier published work by the authors.[6]

The electronic time-varying signals, associated harmonics, and resonance frequencies offer numerous physiologic advantages over older electromedicine devices, such as transcutaneous electrical nerve stimulation (TENS), powered muscle stimulators, microcurrent devices, high-voltage galvanic devices, or interferential current therapy. These advantages include enhancing circulation and local blood flow and increasing cyclic AMP (cAMP) levels necessary for cell healing.[7] In addition, the device helps mitigate inflammation.[7]

To better understand the latter process, one must first understand the characteristics of acute inflammation. Inflammation is characterized by (1) vasodilatation of local blood vessels, with consequent excess local blood flow, (2) increased permeability of capillaries, with leakage of large quantities of fluid into the interstitial spaces, (3) clotting of the fluid in the interstitial spaces because of excessive amounts of fibrinogen and other proteins leaking from capillaries, (4) migration of large numbers of granulocytes and monocytes into the tissue, and (5) swelling of the tissue cells. The inflammatory response produces pain, redness, heat, and swelling.[8]

The intent of chemical interventions (ie, non-steroidal anti-inflammatory drugs) for the treatment of the inflammatory process is to block the process at one or more of the initial steps in the cascade. The authors postulate that EST energy can be used to facilitate the naturally occurring inflammatory process, *without* interfering with the normal inflammatory cascade progression, until inflammation is resolved. This facilitation *accelerates* the anti-inflammatory process to reduce the probability that it becomes drawn out and leads to chronic inflammation. The specific mechanisms of action of the applied electronic signal energy can be used to reduce or modify the undesired symptoms normally present during this inflammation cascade (Figure 1).

EST allows much greater depth of penetration of the varying therapeutic signal energy through the dermal layers and into deeper tissues by using randomly changing higher-frequency signals, which produce lower skin impedance. The ever-changing nature of these signals makes it nearly impossible for the peripheral and central nervous system to accommodate (find ways to defeat the effects of the signals). This unique multiplexed[9] signaling configuration (digitally combined AM and FM signal waves) allows for optimum voltage application, which affects and manipulates voltage-gated channels and receptors within targeted tissue (Figure 2).[10]

Case Report

PC is a 73-year-old Hispanic man who is a bilateral amputee secondary to advanced peripheral vascular disease and a 30-year history of diabetes. He underwent a right above-knee amputation in 2006 and left below-knee amputation in 2008. He has had phantom limb pain for a number of years, which had been controlled with hydrocodone/acetaminophen 10/500 mg qid and tramadol 50 mg tid. There were no aggravating factors for the episodes of his phantom limb pain. The pain was equal on both the left and right sides, with the toes and heels being the primary site of the perceived phantom pain. He describes the episodes of pain as pins and needles, constant, and grades the severity as a 9 to 10 out of 10 on the numerical rating scale.

For approximately 1 month prior to his visit to our clinic, PC had not been able to control the phantom pain with the above-listed medications. In the 3 days prior to coming to the clinic, he had been to local hospitals 3 times for pain control and he was given injections of morphine. During this time, the pain had been constant and severe; only after the third visit to the emergency room and his third injection of morphine did he get some measurable relief.

During the first visit to our clinic, the patient presented as lethargic, nauseated, and he vomited in the examination room during his visit. His fasting blood sugar was 107 mg/dL and his hemoglobin level (AIc) was 7.8%. In addition to his pain medications, the patient was taking insulin (Humulin 70/30) on a sliding scale basis to control his diabetes. His medical history was significant for stage 3 renal failure and heart disease; he had stents placed secondary to a heart attack 3 years prior.

Pain Treatment Regimen

Treatment with specific-parameter EST was initiated daily for the first week and then every other day. Initial digital UHdfg programs parameters were selected to provide anti-inflammatory and nerve-blocking effects. Four venturi-type vacuum electrodes were used on each limb through 4 independent channels of a Resonant Specific Tehnologies/Sanexas neoGEN cell-signaling device, with treatment sessions each averaging 20 minutes. On the first day alone, the patient reported that his pain score went from a 9 to 10 to a 5 out of 10 on the numerical rating scale. Subsequent digital programs were advanced continually to include signals that addressed and treated varying stages of inflammation, pain, edema, circulation, and neural deficits. From late May to early July 2013, the patient received 20 EST treatments, with the phantom limb pain resolving over a 6-week period.

In July 2013, PC suffered several pain exacerbations and started to have pain at phantom sites proximal to the distal feet (eg, in the right lateral ankle, but not the right great toe and not on the left side). The patient was taken to the emergency room again for morphine injections. Subsequently, he was treated with EST at intervals of approximately once or twice a week for the next 2 months for maintenance; any painful exacerbations became confined to the stumps only. PC has elected to continue to be managed with periodic EST-only treatment visits to the clinic on an "as-needed" basis. The frequency of treatments continues to be reduced and his last visit to the clinic was 12 months prior to the date of this report.

Discussion

This case report illustrates the potential for the application of sophisticated and complex electric energy signaling to treat pain of central origin. The patient experienced the elimination of the phantom limb pain over time. This case provides evidence that the central pain was modified, given that he presented with only central

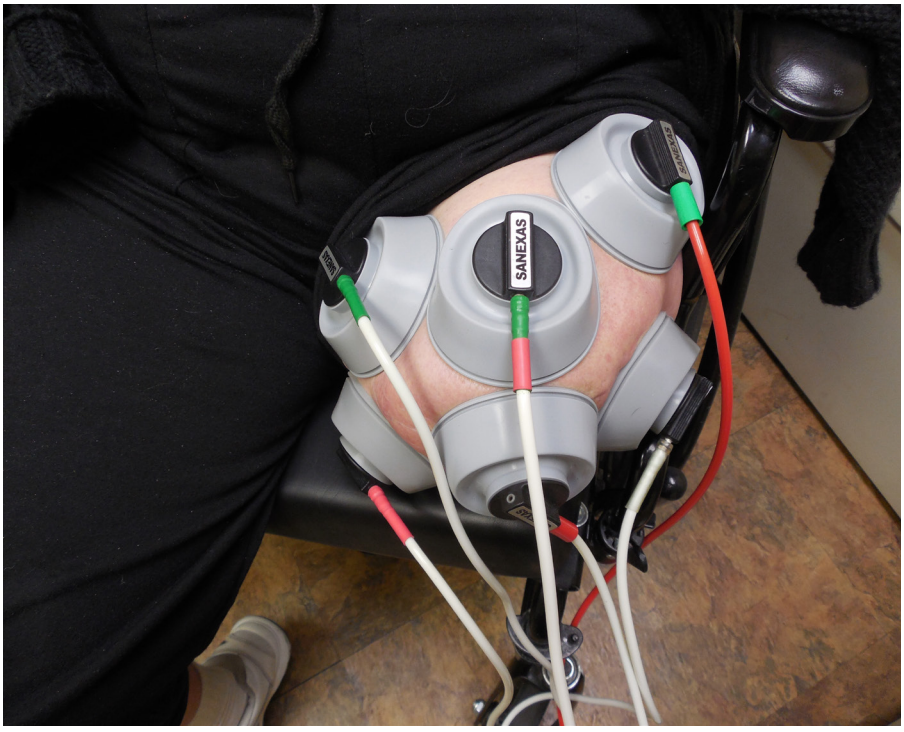

Figure 2. Image of a patient with phantom limb pain undergoing treatment with applied electronic cell signal treatment. You can see the placement of the transcutaneous electrodes with the device.

pain at a more proximal aspect of the injury, namely the stumps, after EST treatment. With ongoing EST treatment, the patient progressed to manifestations of only limited intermittent stump pain. His current exacerbations are confined solely to occasional stump pain, and, with periodic maintenance treatment, he has been relatively easy to manage.

The advantages of electric cell signaling over centrally acting drugs are clear: reduced costs and reduced side effects. The question of reproducibility and comparative efficacy will need to be determined in future studies.

EST shows promise for not only the treatment of diabetic and other peripheral vascular disease–induced limb amputations but also for efficacious treatment of our returning soldiers as well. These multiplexed and continually varied electric signals have a direct effect on voltage-dependent gates, and the alteration in the membrane physiology is measureable objectively.[11] A number of scientific citations demonstrate both conformational changes in the G-proteins of the cell membrane and subsequent second-messenger (cAMP) formation directing cell-specific activity, including regeneration and repair.[12]

The EST is noninvasive, safe, and cost effective. Although the EST device required is far more advanced than typical TENS devices or other traditional electrotherapy devices that are available, its cost is still such that medical clinics nationwide could treat patients in a cost-effective manner. We envision future directions of research and clinical use to include the synergistic incorporation of electric cell–signaling technology with recent developments in quantum physics as they pertain to biologic oscillations, neural networks, cellular microtubule function in energy transfer, proton motive force, and cellular capacity.[13]■

Authors' Bios: *Robert H. Odell, Jr., MD, PhD (biomedical engineering), practices interventional pain management and anesthesiology in Las Vegas, NV. Dr. Odell is a diplomat of the American Board of Anesthesiology, the American Board of Pain Medicine, and the American Academy of Pain Management. He is a fellow of Interventional Pain Practice (FIPP) of the World Institute of Pain.*

Richard Sorgnard, PhD (molecular biology), is Executive Director for Morhea Technologies, LLC, a medical technology development and engineering firm involved in the design, development, engineering, and production of complex electronic equipment and electric signal generation (EST) devices (including FHSS signaling), located in Las Vegas, Nevada. Morhea Technologies is also involved in applied techniques for the medical, governmental, and consumer electronic industries. Dr. Sorgnard is a Diplomat with the American Academy of Pain Management, as well as a consulting technical director for the international Institute for Chronic Disease.

Robert Milne, MD, specializes in Integrative and Complimentary Medicine. He received his undergraduate degree from the University of Southern California. After 3 years in the Peace Corps, he attended the University of Missouri-Columbia School of Medicine where he received his medical degree. Dr. Milne completed 3 years of residency at the University of Texas-Southwestern, John Peter Smith Hospital, where he was chief resident and was awarded Board Certification in Family Practice. Dr. Milne has published several medical journal articles and medical healthcare books. He holds 2 patents on quantum medical devices; the Elast Allergy Testing Device and the Micro-Vibration Therapy™ (MVT) for the treatment of acute and chronic pain conditions.

Roy M. Cary, PA-C, is a physician assistant working with Dr. Odell in Las Vegas, Nevada.

Drs. Odell and Milne have disclosed that they are stock/shareholders of Resonant Specific Technologies, Inc. Dr. Sorgnard is Executive Director of Morhea Tehcnologies.

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