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Case Report

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Utilization of Electronic Cell Signaling to Effect Recovery from Peroneal Neuropathy in Patients with Complete Foot Drop

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Abstract

Our treatment experience indicates that the overall outcome depends most importantly on the actual pathological cause of the problem. The authors have successfully treated patients with motor nerve dysfunction by healing the pathology in about 85% of the cases. Depending on the severity of the patient, treatment may require 2-3 months for the surrounding tissue to stabilize, peroneal nerve to regrow and finally to improve both motor and sensory function.

With some patients who have suffered from long term, severe peroneal nerve damage, complete restoration may remain elusive and the disability may be permanent. However, even in these difficult cases, we have managed to alleviate the accompanying associated pain and inflammation and regain at least 50% of the motor nerve function.

The authors have presented multiple mechanisms, which demonstrate initial facilitation, biosystem stabilization and then quick resolution of the inflammatory process to prevent it from leading to chronic inflammation and chronic pain. Continued treatments with protocol driven, specific-parameter electric signals are then employed to stimulate axon regeneration, neuromuscular training and overall muscle strengthening. While complex, all concepts above fit together when taken into the context of cell signaling and improving cAMP utilization. Through this and the other mechanisms discussed, cellular derangements are returned to normal in a shortened and optimal physiological time.

Keywords

Peroneal neuropathy; Foot drop; Cell signaling

Introduction

Neuropathy is characterized by abnormalities in the function of sensory and motor nerves. The Combined Electrochemical Technique (CET) has been shown to stimulate the growth of epidermal nerves (c and unmyelinated A-delta) fibers [1-3]. In the process of treating sensory neuropathy, our group has treated a subset of patients with foot drop (peroneal motor nerve dysfunction) which has also responded to the protocol.

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Foot drop is an abnormality in which the forefoot cannot be elevated (flexion of ankle) due to irritation, weakness or damage to the common fibular nerve, the sciatic nerve, or paralysis of the muscles in the anterior portion of the lower leg. Foot drop is a common and distressing problem that can lead to falls and injury. A "steppage" gait describes the patient lifting his/her foot higher to avoid its contact with the ground.

Based on source information from the National Institute of Neurological Disorders and Stroke, "Foot drop can be unilateral or bilateral and it is a symptom of an underlying problem that is either temporary or permanent, depending on the cause. Causes may include: peripheral neuropathies, stroke, neurodegenerative disorders of the brain that cause muscular problems, such as multiple sclerosis and cerebral palsy; motor neuron disorders such as polio, some forms of spinal muscular atrophy and amyotrophic lateral sclerosis, injury to the nerve roots, such as in spinal stenosis; peripheral nerve disorders such as peripheral neuropathy or Charcot-Marie-Tooth disease; local compression or damage to the peroneal nerve as it passes across the fibular bone below the knee; and muscle disorders, such as muscular dystrophy or myositis" [4].

Foot drop is caused most frequently by neuropathy of the common peroneal nerve where it wraps around the fibular head, although there are other (more proximal) causes of this neuropathy. A frequent cause is crossing one's legs; this habit can be especially risky when a patient has an underlying sensory neuropathy (see below).

Diagnosis has traditionally been done by a neurological examination, nerve conduction and electromyography studies. Predicting recovery is often difficult, and chronic foot drop is very difficult to reverse. One of our patients was told it would be four years, if at all, before he recovered. Case reports below reveal several different outcomes.

Materials and Methods

At the Neuropathy and Pain Centers of America facility in Las Vegas, Nevada, we routinely see approximately 40 to 50 patients per day with varying types and stages of painful peripheral neuropathy, including diabetic peripheral neuropathy (DPN), chemotherapy-induced peripheral neuropathy (CIPN), and idiopathic peripheral neuropathies.

The range of patient symptoms seen at the clinic has included:

- Decreased sensation, numbness, or tingling in the top of the foot or the outer part of the upper or lower leg
- Foot that drops (unable to hold the foot up)
- Toes drag while walking and general walking problems
- Weakness of the ankles or feet
- Loss of muscle control in the lower legs and feet
- Atrophy of the foot or foreleg muscles
- Difficulty lifting up the foot and toes and making toe-out movements

Our approach for these patients revolves around specific parameter electronic cell signaling treatment (EST), the critical component of functional nerve stimulation [5]. Treatment aims to influence regenerative neural bioprocesses by a variety of mechanisms including a profound anti-inflammatory effect, an increase in cyclic adenosine monophosphate (cAMP), enhanced nerve regeneration (speed), and the reduction of edema and pressure on the nerve [6].

Approximately six percent of our neuropathy patients have presented with common peroneal nerve motor dysfunction (foot drop). Common peroneal nerve dysfunction may be part of a generalized distal symmetric neuropathy also involving the tibial branch of the sciatic nerve. More commonly these distal symmetric neuropathies are sensory only, but this small percentage of patients also has motor involvement. Damage to the nerve destroys the myelin sheath that covers the axon (branch of the nerve cell), or it may destroy the whole nerve cell. There is a loss of feeling, muscle control, muscle tone, and eventual loss of muscle mass because the nerves are not stimulating the muscles [7-9].

All patients were given a full explanation of the risks and benefits of the procedures. The risks of electroanalgesia treatment alone are minimal as documented in previous papers. Written informed consent was obtained from each patient prior to treatment.

Each patient was treated according to our standard neuropathy protocol; programming parameters included, in patients with foot drop, specific neuromuscular re-education parameters in addition to sensory programming parameters. Patients were treated three days each week, including ankle blocks and EST (CET) on Monday and Friday, and electric cell signaling treatment (EST) only on Wednesday. Those patients who had no sensory neuropathy symptoms were treated without the ankle block (EST only). Programs for patients with sensory neuropathy symptoms could be delivered simultaneously with the specific neuromuscular re-education programs; patients without sensory symptoms were delivered with the specific neuromuscular re-education programs only.

The neuromuscular EST programs include an Initial Muscle Activation (oxidative muscle training) and Advanced Muscle Work (training, endurance, anti-thrombolytic). The initial muscle activation sequence utilized a middle frequency of 3500 Hz in four phases with low frequency amplitude modulations in two of the four phases. The Advanced program utilized descending middle frequencies stepping down in 8 phases from 5120 Hz to 3584 Hz with each even phase having low amplitude modulation varying from 1 pps to 4 pps. This complexity serves to stimulate the motor nerve cells while at the same time making accommodation difficult.

Recovery of motor function was graded on the standard Oxford 0-5 scale [7]. Full (normal) muscle function with full resistance is graded 5/5; full (breakaway) muscle function with some resistance (or breakaway function) is 4/5; no muscle function to resistance but ability to function against gravity is graded 3/5; inability to move even against gravity is rated 2/5; only some muscle contraction but no movement is 1/5; and absence of contraction is 0/5 (Table 1).

Setting: Private practice clinic of solo interventional pain management practitioner

Case Descriptions and Results

In a series of nine patients followed prospectively, five patients reported greater than 50% improvement in motor function (ability to lift foot). One of these patients had a full recovery (100%) improvement, noted below. The percent improvement reported was defined by each patient. One patient reported 20% improvement, and one other had no improvement. Our goal was not to enroll a high enough "n" to establish statistically significant results, but merely to report on a series of nine patients treated in 2014.

Table 1: Recovery of motor function was graded on the standard Oxford 0-5 scale.

Muscle Strength Grading Scale (Oxford Scale)	
0/5	No contraction
1/5	Visible muscle contraction but no movement
2/5	Movement with gravity eliminated
3/5	Movement against gravity only
4/5	Movement against gravity with some resistance
5/5	Movement against gravity with full resistance

Case report 1

A 73 year old retired anesthesiologist with a history of diabetes had noted the onset of painful peripheral neuropathy several years prior to seeking care at our clinic. His medical history included a report detailing that he had nearly died from what was proven to be lithium toxicity. After the lithium was stopped, he was recovering from his cognitive dysfunction, but his sensory neuropathy had worsened and he stated that it was increasingly more difficult to raise his right foot off the ground. He consulted a neurosurgeon and a neurologist and underwent several diagnostic tests. It was determined that he had damaged his peroneal nerve most likely from a habit of consistent leg crossing, and recovery would take approximately four years, if at all.

Approximately one week later he sought care at our clinic and our initial motor exam revealed 0/5 motor function. Treatment was initiated using the advanced technology EST device which is capable of delivering specific parameter motor stimulation programs, as well as varied electronically generated AM and FM signal waves [4]. Within one week, the patient's motor function had achieved 4/5 and by five weeks function was completely normal (5/5). The patient was then enrolled in our peripheral neuropathy protocol for his sensory symptoms; over the course of the next two months, he recovered much of his sensory function as well. At a two year follow-up, his motor function was retested and has remained normal and his sensory function has substantially improved with little or no remaining pain.

Case report 2

A 76 year old female Nurse Practitioner underwent a right hip replacement five years prior to presenting at our clinic. The right foot drop was noted in the recovery room immediately following the surgery. At that time she had sharp, jabbing pain, numbness and tingling along with dysesthesias of the entire right leg. She reported numbness and tingling with dysesthesias into the right calf down to the right foot and ankle. The right foot drop was constant at 1/5 motor function with intermittent episodes of electric shock sensations into her right calf, ankle and foot. The symptoms were aggravated with standing and sitting, with no relieving factors. EMG had shown that she had right sided peroneal nerve damage.

EST was initiated on a three times weekly basis to address the painful sensations in the calf. Concomitantly, a separate device channel was programmed with specific-parameter neuromuscular training frequency parameters to address the drop foot motor dysfunction. After four weeks of treatment, she reported a motor

function increase to 4/5 and nearly completes elimination of the painful sporadic sensations as well as a 10-15% reduction in overall numbness. Improvements have been noted in her balance, quality of life, reduced use of pain medication and sleep. Her functional improvement is significant and she is walking much better.

Case report 3

A 55 year old male presented with left foot drop (1/5 motor function) along with numbness of the left lateral calf as well as numbness and burning pain in the dorsal and plantar surface of the left foot after undergoing a left hip arthroplasty three months prior to his visit to our clinic. EMG and a nerve conduction study indicated that during the surgery the nerve had been stretched. Sensation on the left lateral calf as well as the symptoms in the left foot and ankle were constant and aggravated with walking and seemed to be worse in the late afternoon and night.

Electric cell signaling treatment (EST) was applied on a three times weekly basis to address the numbness, burning pain in the calf, as well as the dorsal and plantar surfaces of the left foot. Alternately, in subsequent same day treatments, specific-parameter neuromuscular parameters were applied to address the motor dysfunction and foot drop. After 6 weeks of this treatment protocol, he reported a 65-75% reduction in painful sensations and numbness and an improvement of the motor function to the left foot to 4/5. He was satisfied with treatment and was discharged.

Discussion

One of the most significant scientific developments in understanding human physiology occurred when Becker and Seldon [8] (1982) electrically induced limb and nerve tissue regeneration in frogs and rats. They reasoned that specific frequency-range electromagnetic fields exist that must control all aspects of bioprocesses. These studies of extra-neuronal analog electrical morphogenetic fields have secured the importance of bioelectricity for all basic bioprocesses. Becker and Seldon stated in their landmark book that modern scientific knowledge of life's electrical dimension has yielded fundamental insights into pain, inflammation, healing, growth, consciousness, and the nature of life itself.

A number of papers that detail the various physiologic mechanisms of action available from the use of specific parameter and/or varied parameter electric cell signaling have been published recently [1,5,9-12]. These bioenergetic mechanisms are paramount to the understanding of how functional recovery from foot drop is achieved.

Cyclic AMP formation

Research has shown that electric cell signal treatment (EST) has a direct effect upon ACTH stimulation, which controls the secretion of cortisol. This is the body's own "measured steroid response." Cortisol has two basic anti-inflammatory effects: 1) it can block the early stages of the inflammation process or 2) if inflammation has already begun, it causes rapid resolution of the inflammation and increased rapidity of healing. It is believed that cortisol effects assist in the liberation and mobilization of amino acids that can be used to repair the damaged tissues. EST signal energy releases noradrenalin from sympathetic nerve endings resulting in a reaction with receptors on the cell membrane [13]. This triggers cAMP formation from ATP and increased or normalized cAMP activates metabolic processes in the cell.

Inflammation modulation

The mechanism by which ACTH activates cortisol from adrenocortical cells is a function of cyclic Adenosine Monophosphate (cAMP). The principal effect of ACTH on the adrenocortical cells is to activate adenyl cyclase in the cell membrane, which induces the formation of cAMP. The cAMP in turn activates the intracellular enzymes that cause the formation of the adrenocortical hormones. EST also facilitates the naturally occurring processes necessary for control and mitigation of inflammatory conditions without the usual undesired side effects that accompany the introduction of chemical steroid compounds.

Since second messenger formation (cAMP) directs cell specific activity to membrane repair and stabilization, arachidonic acid release from membrane breakdown is diminished and the prostaglandin (inflammation and pain mediator) cascade is attenuated or terminated.

Immune system support

EST appears to improve and support the immune system (unlike chemical steroids) by improving gap-junction intercellular communication via EST oscillo/torsional effects.

Gap junctions are protein-lined channels that directly link the cytosol of one cell with another adjacent cell providing a passageway for movement of very small molecules and ions between the cells. This allows metabolic coupling or metabolic cooperation between cells. cAMP is another important compound transferred from cell to cell through gap junction. The fact that cAMP can transfer from cell to cell through gap junctions means that hormonal stimulation of just one or a few cells can initiate a metabolic reaction in many of them. Gap junctions are also influenced by many other changes in their surroundings, i.e. by changes in the electric membrane potential or the phosphorylation of substances inside the cells produced by hormonal attachment on receptor molecules, which transfer information via signal molecules. This transfer and the common use of small molecules is the basis for intercellular metabolic cooperation and fulfill the precondition for intercellular chemical and electric cooperation.

EST energy influences the electrically charged ion movements through gap junctions by increasing the transport through the cell to cell canals and by facilitating intercellular electric and chemical communication and metabolic cooperation. EST energy fields contribute to a functional improvement in tissues which are dysfunctional, e.g., in the healing phase of injured tissue, in degenerative tissue changes, in metabolic conditions, in edema, and in regions of decreased blood supply.

Circulatory influence [15]

The physiological effects (metabolic challenge) of electronic signal energy on motor nerves and muscle stimulation are accomplished by lower frequencies. This effect results in subsequent increased metabolism autoregulatory vascular mechanisms that produce a decrease in peripheral resistance of the vasculature in the stimulated treatment field. These autoregulatory vascular mechanisms are controlled by the end products of metabolism - CO_2, lactate (pH decrease), and adenosine release. ATP consumption is initiated by depolarization of excitable cells and because these cells attempt to immediately repolarize their membrane potential, there is an increased demand for ATP as the source of energy.

Signaling cAMP leads to the opening of voltage gated channels in efferent c-fibers of pain neurons and the sympathetic nervous system. Vessels will then vasodilate, increasing local circulation, allow incoming nutrients and the washing out of waste products. This cascade will eliminate the primary chemical causes of local pain [6]. In addition, signaling cAMP also leads to decreased afferent c-fiber firing, which in turn decreases ephatic cross firing of afferent A-delta fibers [6].

Multiple mechanisms of action apply in the treatment of drop foot conditions with EST. When lower frequency parameters are employed at dosage levels above the nerve's firing threshold, the activated nerve stimulation would enhance the centripetal transport of venous blood and lymph via sympathetic stimulation, as well as enhancing nerve regeneration and neuromuscular training. Higher EST dosage, above the muscle contraction threshold, would activate the muscle pump response, enhancing also the centripetal flow of blood and lymph.

Specific parameters are utilized which are known to stimulate motor nerve recovery. For example, 10 Hz has been found to best stimulate and accelerate nerve axon growth. These parameters can be used if the electric cell signaling device has programming capabilities which include AM, FM and primary (carrier) frequency sweeping. Only a limited set of devices on the international market are capable of this kind of programming [3,4]. Other specific programs can be used to stimulate muscle conditioning. These motor capabilities have been referred to as "sofa jogging" when applied to the patient with diabetic neuropathy in order to help the pertinent "exercise in place" and promote the utilization of blood glucose.

EST has a remarkable track record of safety. Clinics that have used our protocol for patients with neuropathic pain in the feet and legs have rarely, if ever, observed side effects. In our experience, occasional mild, superficial dermal tissue burns have been reported from adhesive-type electrodes when excessive power density is applied.

These problems have been resolved by using a venturi-type vacuum cup electrode system. There have been no reports of infection to date. Any patient with foot drop can be treated with EST. There are virtually no contraindications since the treatment is completely non-invasive.

Conclusion

This is the first study to report the use of EST in the treatment of foot drop. Because of its effectiveness and the virtual lack of risk related to this treatment, EST/CET has the potential to make a significant impact on the patients with this difficult to treat neurological problem. The successful treatment of foot drop in a significant percentage of the population would reduce falls and other morbidity. All current treatments for foot drop are much less effective and much more costly.

Electric cell signaling treatment (EST) involves physical science and not chemistry. Therefore, it is considerably more natural and physiological to the human body.

While we believe that additional studies involving EST as a treatment for the functional recovery in foot drop are important, there appears to be enough evidence to encourage the primary or adjuvant use of EST for this condition.

Finally, we believe that EST and the evidence presented have placed us on a threshold of discovery; it is time to apply this knowledge in the clinical setting. The alternative role of EST (the electric signaling of the cells) will depend on the outcomes of well conducted clinical trials which utilize this reasonable and safe approach.

We envision future directions of research and clinical use to include the synergistic and cost saving incorporation of electric cell signaling technology with recent developments in the field of quantum biophysics and nerve regeneration.

References

1. Odell RH, Sorgnard RE, Carney P, Milne RE (2015) Combined Electrochemical Treatment for Peripheral Neuropathy. Practical Pain Management.
2. Carney PM (2014) Quantum Theory Treats Neuropathy Better Than Pharmacology. The Pain Practitioner: 24: 28-31.
3. Carney PM (2016) Helping Patients with Pain from Peripheral Neuropathy (PPN) without harming them. Poster.
4. Presentation (2016) World Institute of Pain World Congress, New York.
5. EST device provided by RSTmed Corporation, Las Vegas, NV.
6. Odell RH, Sorgnard RE (2008) Anti-Inflammatory Effects of Electronic Signal Treatment. Pain Physician: 11: 891.
7. Advance for NP
8. Becker RO, Selden G (1985) The Body Electric. New York, Morrow ISBN-10: 0688069711.
9. Odell RH, Sorgnard RE (2011) New Device Combines Electrical Currents and Local Anesthetic for Pain Management. Practical Pain Management 11: 52-68.
10. Cernak C, Odell RH, Carney P (2014) Editorial: Can Combined Electrochemical Treatment Have An Impact For Diabetic Peripheral Neuropathy? Podiatry Today 27.
11. Cernak C, Larsen EM, Odell RH (2015) Editorial: Mitigating Some Guesswork in Treating Neuropathic Pain. Podiatry Today 28: 6.
12. Cernak C, Marriot E, Martini M, Fleishmann M (2012) Electric Current and Local Anesthetic Combination Successfully Treats Pain Associated with Diabetic Neuropathy. Prac Pain Mgment 2012: 24-36.
13. Knedlitscheck G (1994) Cyclic AMP response in cells exposed to electric fields of different frequencies and intensities. Radiation Environmental Biophysics 32: 1-7.
14. Gap junctions: basic structure and function. NCBI – NIH
15. Higher EST frequency and dosage has a blocking effect on sympathetic vasoconstrictor nerve fibers resulting in vasodilatation within the vasculature innervated by these sympathetic fibers. In this way, blocking afferent c-fibers increases local circulation.

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