Modern Low Voltage
Microcurrent Stimulation: A Comprehensive Overview

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Introduction

Modern low voltage pulse microamp stimulation was invented by a chiropractor, the author, and so it is natural that chiropractors are leading the way in using MENS therapy.

Because chiropractors are open-minded when it comes to "anything that works," they did not wait to use low voltage pulsed microcurrent stimulation until prestigious institutions spent years of study to confirm its validity. They started using it right away in their practices to give their patients the benefits of this emerging technology.

Since then, a great deal of additional data has been presented, and recently these new findings have been summarized in a paper by Robert Picker, MD, in Clinical Management 1, in which he discusses current research documentation of microcurrent stimulation and suggests the importance of polarity in therapy. The author takes this opportunity to present excerpts from Dr. Picker's well researched paper which adds to the current data on microcurrent therapy.

NBA championship basketball teams the L.A. Lakers (1987-1988) and the Detroit Pistons (1989), San Francisco 49 er's Super Bowl football champs, four-gold medal Olympian Carl Lewis, Jackie Kersey-Joyner (woman athlete of the world, 1988), and the 1987 baseball champion N.Y. Mets all used MENS microcurrent therapy 2 because it works.

Current Bioelectric Research

New and exciting documentation by researchers on the effects of electricity in life and healing is being reported in this article. The book The Body Electric by Robert O. Becker, MD, covering his and others work on electricity and its relationship to healing and life, is an astounding autobiography of his research conducted against the wishes of the medical establishment 3 .The portion on electrical stimulation is being reviewed. Becker's book should be of interest to every chiropractor as his findings in bioelectric research shed light that could eventually explain and document chiropractic as an exact science.

Nordenstrom, a Norwegian radiologist, offers a new approach to how the body healing is enhanced by electricity 4. Microcurrent MENS therapy is finally gaining medical acceptance and soon may be a standard medical procedure.

The Flexner Report

Andrew Carnegie's philanthropy benefited Americans by gifts of libraries (one in which the writer spent much of his childhood haunting the stacks), among other things, but one

gift strangely deprived Americans of the benefits of electrical therapy for at least a half century, and discouraged its scientific research.

A major study of American medicine, financed by the Carnegie Foundation and published in 1910 by Abraham Flexner, denounced the clinical application of electric therapy that had been in use since the mid-century. It had gotten a bad name from exploitation and legitimate users had no scientific data to defend it.

The reforms in medical education following the report by flexner, a respected educator, drove all mention of it from the classroom and clinic.

Coinciding with the discovery of acetylcholine, a chemical messenger, the last defenders in the belief of vital electricity were purged from biology and the medical path then followed the expanding knowledge of biochemistry and became drug oriented. Within 10 years, no one who wanted the respect of the scientific community would suggest life was in any sense electrical, and anyone who did was promptly branded a fraud.

As the AMA grew in power, other healing arts were ruthlessly attacked; so by the 20 's chiropractors and osteopaths banded together to pass initiative acts in California for licensed professions. This was repeated in a number of other states, although some states have limited chiropractors to manual manipulation.

Bioelectricity - The Basis of Life?

The premise that electricity has basis for control of living tissue received a big boost from the work of Robert O. Becker, MD. Dr. Becker is a leading pioneer in the field of regeneration and its relationship to electrical currents in living things. He found clues to the healing process in the long-discarded theory of the 18 th century Vitalists that electricity is vital to the life process.

The following is a briefly summarized report on portions of his book. Becker says it best:

"Everything electrical stems from the phenomenon of charge. No one knows exactly what this is except to say it's a fundamental property of matter that exists in two opposite forms or polarities, which we arbitrarily call positive and negative.

"Protons, which are one of the two main types of particles in atomic nuclei, are positive; the other particles, the neutrons, are so named because they have no charge. Orbiting around the nucleus are electrons, in the same number as protons inside the nucleus. Although the electron is 1,836 times less massive than the proton, the electron carries an equal but opposite (negative) charge. Because of their lightness and their position outside the nucleus, electrons are much more easily dislodge from atoms than are protons, so they are the main carriers of electric charge.

"For the layperson's purposes a negative charge can be thought of as a surplus of electrons, while a positive charge can be considered a scarcity of them. When electrons move away from an area it becomes positively charged, and the area to which they flow becomes negative.

"The flow of electrons is called a current,... direct current is more or less even flow as opposed to the instantaneous discharge of static electricity as sparks or lightning, or the back and forth flow of alternating currents (AC) which powers most of our appliances."

How Electricity is Conducted

Prior to the 1930 's, there were only two known ways for current conduction: metallic (such as wires) and ionic. (Figure 1A) shows metal conduction as a cloud of electrons moving on the surface of the metal such as the old-fashioned bucket brigade to fight fires. This method can be excluded from the human body as no metallic conductors exist except those implanted by man. Ionic current (Figure 1B) conducts in solution by the movement of ions, atoms or molecules.

Since ions are much bigger than electrons, they move laboriously through the conducting medium and die out after a short distance. Becker says they work well enough across the membrane of the nerve fiber, but it would be impossible to sustain an ionic current the length of even the shortest nerve.

A third way to conduct current in the body was not understood until the semiconductor theory was developed in the 30 's. Semiconductors are halfway between an insulator and an conductor, and they carry only small currents. However, they readily conduct over long distances and work fine in the human body.

What are Semiconductors?

Semiconductors occur only in materials having orderly molecular structure, such as crystals. Szent-Gyorgy pointed out that molecular structures of many parts of the cell are regular enough to support semiconduction in his 1960 book Introduction to Submolecular Biology. Becker feels this semiconduction in body tissue theory may be man's most important contribution to science.

Becker theorized that a naturally occurring "current of injury" is measurable in the body and hypothesized that this current was conducted via the Schwann and glial cell sheaths that surround neurons to an area of injury, thus triggering tissue repair 5 and regeneration.

Dr. Picker states "Recent research into injury currents has surprisingly early roots, going back to the measurements of wound potentials and injury currents made by Dubors-Reymond during the Civil War (1860 's). Illingsworth and Barker (1980) recently measured the currents generated by the amputated stump of a child's fingertip. These stump currents were found to be microcurrent in intensity and within the 10 to 30 µA CM2 range. Other researchers Borgens et al. (1980) reported similar findings, although it has been only recently that science has been able to realize their implications and to therapeutically apply similar microcurrents."

Body Polarity Theories

Becker found in his research that the human body has polarity similar to that of animals. Figure 2 shows the polarity of a representative group studied from an earthworm, flatworm, fish and salamander to a human. Becker found the human body is positively

polarized along the central spinal axis and negatively peripherally. The normal voltage reading would be - 10 μA, however when a fracture occurred, the voltage is decreased toward zero. Five days later the voltage is nudging slightly toward normal, and by the 10 th day, the voltage reading is nearly normal, with normal voltage reading of -10 on the 15 th day. Becker's experiment showed the potential difference of a normal voltage reading on an animal as compared to the voltage of the initial fracture and its return toward normal after healing set in.

He feels the polarity gradient set up by the voltage potential differentials is the electromotive force driving the bioelectric currents in the body and the current of injury.

Another researcher who share similar views is Born Nordenstrom, MD, who in 1983 published his findings on bioelectric circuits and how the body turns them on to accomplish healing. Nordenstrom proposes that bioelectricity is conducted through the intercapillary circulatory system.

When an injury occurs, a positive charge builds up in the area and sets up the voltage potential differences, serving as a bioelectric battery waiting to be turned on.

This bioelectric charge is then switch on by a change in the electrical insulating properties of the capillary membranes. As the membranes become less permeable to the flow of ions and more electrically insulated, the flow of intrinsic bioelectricity now is forced to take the path of least resistance, which is through the bloodstream. The bioelectric currents of energy, by following the increased blood flow, are directed to the site of pathology. Nordenstrom's theory is compatible to Becker's work.

Microcurrent Experiment of Regeneration

Sinyukhin, a researcher of Lomonosov State University of Moscow, reported his experiment of cutting one branch of a series of tomato plants and measuring the electrical currents around each wound. He found negative current flowing from the wound the first few days and similar current of injury emitting from all animal wounds. The next week, after a callus formed over the wound, the currents increased and reversed polarity to positive.

Sinyukhin then applied extra current using small batteries to a group of newly topped plants to augment the current. The electrical stimulation restored the branches up to three times faster than the control plants, even though the currents were only two to three microamperes for five days. Larger amounts of current killed the cells or had no growth enhancing effects. It was also necessary to match the polarity. When the opposite polarity was applied, the restitution was delayed two or three weeks.

Modern Microcurrent Therapy Update

Dr. Picker says "MENS low voltage pulsed microamp stimulation produces current density that is not sufficient to excite motor nerves. Its well-known first cousin, high voltage pulsed current, a widely used and well-accepted modality, can obviously produce muscle contractions and everyone assumes "it works," whereas, with MENS low voltage

microcurrent subliminal stimulation, the patient must rely on improvement to know "it works."

The Differences Between High and Low Voltage Modalities

"There is a remarkable similarity in the current as both are microcurrent, both are pulsed, but from there on the sameness ends. High voltage devices produce a fixed voltage between 150 to 500 V, whereas the modern low voltage microamp stimulators are automatic, adjusting moment to moment to keep the current constant. This impedance/sensitive voltage adaptability is an essential feature of the constant current generator.

"Constant current technology is designed to use only as much voltage as necessary up to the designated maximum as selected by the user. As an area of increased resistance is encountered, the voltage increases commensurable to maintain the desired current flow as based on Ohm's law."

The two microcurrent stimulation devices have different dilutions to achieve tissue penetration with these extremely low currents: "High voltage therapy does it by driving the current with a fixed voltage in generous quantities, since the voltage is not adaptable, for variations of specific tissue resistances encountered. It is not current constant since the current is reduced by increase in tissue resistance. I=E/R is the common Ohm's law formula (I-current in amperes, E-voltage, and R-resistance in ohms). Thus excessive current can be applied with reduction of tissue resistance."

"Another related dissimilarity is the duration and intensity of the pulses. High voltage stimulation is characterized by brief 5 to 200 microseconds with sufficiently high intensity for excitation of sensory and motor nerves. As the frequency is increased, each additional pulse increases the total energy delivered. In contrast with low voltage MENS, the stimulation is spread over an extremely long pulse duration of 50 percent duty cycle, meaning that regardless of the frequency selected, the current is on for 50 percent of the time and off for 50 percent of the time. The pulse duration is always equal to the interpulse rest interval regardless of the frequency. Thus MENS devices can be relied upon to deliver no more than the preselected currents and energy. It also has an extremely gradual ramped wave slope which gently and gradually increases the stimulating signal. This is particularly important in treating recently traumatized tissue. Science recognizes that for every action, there is an equal reaction. The gentle action of MENS naturally causes less reaction against each stimulation."

Dr. Picker observed that, in spite of the apparent differences of reaction of the high voltage stimulator as compared to low voltage MENS, there is a very comparable output similarity. Based on one pulse per second, it is shown that in 12.5 µA pulse of the high volt as compared to the 10 µA pulsed of low voltage is little over twice the actual delivered energy.

This is surprising since the high volt units appear much much more powerful, but since the low volt MENS stimulators produce steady output for half the time rather than brief

microsecond pulses of from 5 to 200 millionth of a second, the accumulated total power can be considerable.

Dr. Picker goes further: "A recent textbook 6 on high volt stimulation states, "High peak" intensity is one of the more recognizable characteristics of high voltage stimulators. However, by markedly reducing the peak current of the microamp current delivery so that it is no longer sensory but rather subsensory in nature, some proponents of microamp stimulation believe that the body may more comfortable and perhaps more efficiently accept this electrical energy into its own electrophysiological healing system."

An analogy seems worth considering: A single sharp, piercing shout might equate in terms of total decibels per unit of time to a very long, soft whisper, yet do we perceive and receive it the same despite the radical difference in peak intensity? The aptness of such an analogy is certainly open to question and will not be satisfactorily answered until more research is conducted on this entire topic.

"It is hoped that present and future studies will test the following hypothesis: that microamp currents closely approximated the naturally occurring bioelectric currents in the body's tissue healing and repair."

Healing Ability of MENS Therapy

What do researchers say about the healing ability of microamp stimulation? PT research associate professor of Rehabilitation Medicine at New York University Medical Center, Neil Spielholtz, Ph.D., summarized the results of studies on tendon repair in experimental animals conducted at his laboratory. "It is interesting to note in this study," he says, "that the group with the 10 times higher current (400µA) certainly didn't have stronger tendons. In fact, they were actually not as strong as the 40 µA group. My gut feeling is that the higher you go, the less beneficial the effect. I wouldn't be surprised to find that milliamps actually turn out to be counterproductive." 7

Century - Old Theory Applicable Today

"Could the theory of Rudolf Arndt (1835 - 1900) and Hugo Schulz (1853 - 1932) apply to modern clinical electrotherapy? This century-old theory of "weak stimuli increases physiologic activity and very strong stimuli inhibits or abolishes activity," the Arndt-Schulz law 8 seems to address the assumption that microamperage (µA) currents are better than currents of higher amptitude at enhancing cellular physiology processes than are milliampere ranges.

"Several studies have documented the enhancing effects of microamps on wound healing (Carley and Wainapel, 1985; Assimacopoulos, 1968; Walcott et at. 1969; Gault and Gatens, 1976; Barron et al. 1985; Alvarex et al. 1983; Messler and Mass, 1985; Stanish 1984; Kloth and Fedar, 1988). Other studies have demonstrated the positive effect of microcurrents on tendon repair in animal models. Nessler and Mass's (1985) study of microelectricaly stimulated tendons demonstrated 91% higher proline uptake than control tendons after seven days of stimulation, while hydroxyproline activity was increased by 255 percent versus controls. Upon histological examination, Nessler and Mass concluded that tenoplast repair was enhanced by microamp stimulation.

"William Slandish, MD, physician for the Canadian Olympic team, found that implanted electrodes delivering 10-20 µA of current hastened the recovery of injured athletes suffering from ruptured ligaments and tendons. Using microcurrent stimulation, Slandish shortened the normal 18 month recovery period to only six months (Slandish 1984)."

Enhancement of Cellular Physiology

"Microamps stimulation has also been called 'biostimulation' or 'bioelectric therapy' because of its ability to stimulate cellular physiology and growth." In a study with important implications for microcurrent electrotherapy, Cheng et al. (1982) studied the effects of electrical currents of various intensities on three variables critical to the healing process: adenosine triphosphate (ATP) generation, protein synthesis, and membrane transport. At 500 µA, ATP generation in rat skin increased almost 500 percent, which the authors concluded as a 'remarkable increase.' What happened with more intense stimulation? Between 1,000 and 5,000 µA (1 to 5 milliamperes), ATP generation nose-dives, and at 5,000 µA (5 milliamperes) it dropped below baseline control levels.

"A very similar picture emerges with amino acid transport and protein synthesis. Amino-acid transport was increased 30 to 40 percent above control levels using 100 to 500 µA (Microamps). As the current was increased, these biostimulatory effects were reversed, with currents exceeding 1,000 µA reducing amino isobutyric acid uptake by 20 to 73 percent and inhibiting protein synthesis by as much as 50 percent!"

Picker poses a question, "Have we been electrically brutalizing the body with high milliamperes, when we would be better advised to whisper the key words with MENS stimulation more consistent with the body's own bioelectric healing systems?"

Picker's Overview of Therapeutic Electrical Stimulation

Microcurrent electrical stimulation has been used as an effective treatment for non-tumor bone fracture for several years (Brighten 1981; Friedenberg 1966; Friedenberg 1981; Yasuda 1953).

The cathodal (negative) current has been shown to be successful in stimulating bone deposition and repair if applied to the fracture site as an indwelling electrode.

Consistent with this empirically successful clinical approach to stimulating bone repair is the observation that injury to bone produces negative voltage potential gradients in the area of injury relative to the undamaged bone.

Short-lives potential differences are also induced by stressing the bone with a mechanical load (Fukada and Yasuda 1957.) Preferential bringing of positive or negative ions within the fluid channels in the bone as it is stressed creates naturally occurring "piezoelectric) or extrinsic source can stimulate bone growth, repair, and remodeling.

To date, the best research evidence in favor of microcurrent stimulation supports negative microcurrents as being more effective with bone and nerve repair and regeneration, while anodal (positive) microamp stimulation appears more effective in healing skin lesions.

Contradictions appear in literature regarding optimal polarity with tendon injuries (Owoeye, Speilholtz et al. 1987; Stanish 1988). In light of these clinical considerations, a maximally effective microcurrent instrument should probably include both anodal and cathodal monophasic stimulation, such as the Tsunami Wave 9, with wave pulse trains that switch polarities every two to four seconds to allow both polarities to be available and allow the cells to select the polarity desired (Wing 1979).

Both becker and Nordenstrom believe that unraveling the secrets of bioelectricity will allow medical professionals to harness this power for therapeutic use.

Enhancing the naturally occurring stump microcurrents by applying similar microcurrent stimulation in the proper polarity does appear to enhance the healing process, whereas regeneration can be inhibited by the stimulator current in the opposite polarity (Vanable et al. 1983).

Based on Becker, Borgen and Sinyukhin's findings, some proponents of microamp currents advocate the use of the positive electrode placement proximally on the spinal column (this is often at the origin of the spinal nerve root from the spinal foramen). Placement of the negative electrode distally is recommended.

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1 Robert Picker, MD, *Clinical Management*, Vol. 9 No. 2, 1989.

2 My-O-Matic-i, manufactured by Monad Corporation, 908 E. Holt Ave, Pomona, CA 91767.

3 Robert O. Becker, MD and Gary Selbon, *Body Electric*. Published by William Marrow and co., Inc., 105 Madison Ave, New York, NY 10016.

4 Nordenstrom, Biological Closed Electric Circuits: clinical, experimental, and theoretical evidence for additional circulatory system.

5 Thomas Wing, DC, ETR - Enhancement of Tissue Repair, *Chiropractic Economics*, Nov/Dec 1979

6 Alon and De Domenico, 1987

7 Spielholtz, personal communication 1988.

8 Dorland's, 1985