



'Frequency Specific Treatments for Neuro-Muscular and Orthopedic Injuries'

By

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Electro-Stimulative treatments, used in both veterinary and human applications for a variety of conditions, appear to be frequency specific if the optimum effect is to be achieved. Nerve injuries and pain perception appear to favorably respond at different frequencies to other soft tissue injuries. A continuous stream of pulses, as opposed to a gated amount, better assists the repair of Bones and Cartilage. This short paper theorizes about possible explanations for this phenomenon from within the body's own natural frequencies and excitations.

Electro-Stimulation for the purposes of this article covers such modalities as Pulsed-Electromagnetic Therapy, Phototherapy and possibly Micro-Current Treatments. It may also apply to other types such as Interferential and Ultrasound. In fact, wherever an application of an externally generated stimulus may cause changes of an electro-chemical nature in tissue.

Homeostasis within all living bodies depends upon systems of feedback and control. This equally applies to the Central, Peripheral nervous systems and Endocrine system. Injuries and disease off balance homeostasis and elicit some form of response. Many of these responses are in the form of action potential signals to and from the brain, which have specific rates of repetition (frequency).

The different frequencies within the central and peripheral nervous systems arise out of their specific purpose and type of nervous tissue. Nerves are classified into three types: A, B and C. 'A' type nerves are found where motor, proprioceptive and nociceptive responses are found. That is to say where muscles are innervated and the brain gathers sensory feedback information to maintain homeostasis in balance, pain avoidance etc. These nerves are myelinated and have action potentials traveling along them at speed of around 150 meters per second. 'B' type nerves are also myelinated but have slower rates of transmission of action potentials and generally serve viscera as part of the autonomic nervous system. Their transmission speeds are 3 to 4 meters per second. 'C' type nerves are possibly the ones of more interest in general pain relief treatment. These are unmyelinated types with very slow transmission speeds arising from nociceptors from all around the body.

The repetition rates of action potentials clearly have maximum limits. 'A' nerve repetitions can be up to 10,000 per second depending upon the intensity of the stimulus and the absolute refractory time of neural fibers and chemical or electrical synapses. At the other end of the scale, action potentials arising from pain receptors are transmitted via 'C' type nerves and have individual durations from resting time to resting time of up to 5 milli secs. This would allow a maximum stimulation frequency of 200 to 300 Hz. What actually limits these action potential repetitions for all three types of nerves is the absolute refractory time. This is the time that an action potential can normally be retransmitted following one just sent. Any action potential arising before this time may give rise to another one being sent but as the chemistry of the previous action potential nerve fibers have not completed the cycle of the



original one, then the second action potential has to overcome the shortfall that is left, that is they have to be more energetic than the previous. The time in the action potential cycle that this can occur is called the relative refractory period. Any action potential arising before this time has no effect.

Pain signals arise from the stimulation of free nerve endings sited in the epidermis. Injury to adjacent cells causes the release of a chemical transmitter (usually prostaglandin or histamines). This spreads about the area and activates the pain sensors causing them to transmit a regular pattern of action potentials along the 'C' nerves for as long as the neuro transmitters are being released. Analgesics such as aspirin and ibuprofen work by reducing the level of neuro transmitter released by the injured cells. Applying therapies such as pulsed magnetic therapy at specific frequencies around the maximum repetition rate may have two effects. The first is to change the Na⁺ concentrations around the free nerve ending pain receptors by general hyperpolarisation. This would then require higher levels of neuro transmitter to cause the sodium channels to open and then cause impulses to be generated. The second possible effect would be to add to the stream of action potentials generated by electromagnetic induction directly into the 'C' nerve. These pseudo action potentials may cause the stream to be interrupted by causing a prolonged hyperpolarisation effect at the nerve fiber itself. Clearly in the case of the second possible effect a frequency near to the maximum would be required to achieve a confusion and chemical block to the regular stream of pain impulses. Hence for such persistent pain a frequency of 200 Hz and above is required.

Naturally occurring frequencies in bone, such as a long bone, are found by studying natural resonance. Bone has two possible frequencies at which it may resonate when stimulated by every day occurrences such as slight shocks and bumps from normal movements. One of these frequencies is the 'bone alone' mechanical resonance. All objects with mass have a natural resonance and bone is no exception. Our experiments carried out at Salford University looked typically at the tibia and found dry bone resonances of around 150Hz for the bone as a whole. Variations for the adult bone varied slightly, as would have been expected, with dimensional and density differences, but these were not too significant. When tibial resonances in vivo were measured, the frequency significantly lowered because of several factors. These were;

1. The tone of the surrounding muscle.
2. The fluidic density of the total environment in which the bone was immersed
3. The state of the bone itself.

The significance of these frequencies comes into play when measurements of the damped oscillatory frequencies are taken. Typical frequencies were found to be around 100 Hz.

Stimulating bone with pulsed magnetism would have two significant effects. First, it would induce small electric currents into the bone, which may mimic those established naturally by piezo electric means and processed by the collagen/apatite junctions in the same way. The second effect is that in inducing these small currents,



a voltage would be established which would cause the crystalline structure of the bone to contract then release back to its normal shape as the voltage ceases, producing a damped oscillation. This is normal with any voltage applied across the faces of a crystal. In doing so the frequency of the damped oscillation would be directly dependant upon the mechanical resonance of the structure. Applying the 50Hz pulsed magnetism would, therefore, cause the bone to begin to vibrate at its own natural resonance by providing a 'tap' in sympathy with every other vibration cycle. This vibration would be minute but perhaps sufficient to amplify the induced voltages thereby attracting osteoblasts to the area more effectively. Applying the 50Hz instead of the 100Hz would allow the bone to more easily settle into its own resonance and be more natural than forcing the pace with 100Hz. This may increase the healing potential of the treatment.

In writing this article I have focused on the potential of frequency specific pulsed magnetism. It follows that other treatment methods may also be more effective by adopting the frequency and rate of application to those naturally occurring in the body of the patient. Vibrative massage at 50Hz may have similar effects to the pulsed magnetism mentioned above. Micro current stimulation along nerves used as a treatment to reduce pain may be better pulsed than applied as a direct current especially if in sympathy with or slightly higher than the naturally occurring action potential repetition rates.