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Super Magnetic Induction : Therapeutic Efficacy in Osteoarticular Pathologies

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In order to talk about super magnetic induction, I think it is appropriate to refer to what magnetic fields are.

As already intuited by Faraday, electricity is a vector quantity. Bohr then proposes an ideal model of an atom with a central nucleus and the electrons arranged on orbits that continuously revolve around it. Because of this motion the electron becomes charged creating an electric force, the electric field.

Suppose we swing this electron back and forth: this would produce a perturbation of the electric field due to the change in the electron's distance. This change in the electric field generates the magnetic field.

These oscillations between electric field and magnetic field produce the ELECTROMAGNETIC WAVE, which is any energy activity that can pass through matter. It has characteristics that are:

- THE PERIOD the time required to make a complete oscillation
- FREQUENCY the number of oscillations per unit time and is measured in Hrtz
- WAVE LENGTH the distance traveled by the wave in one period
- INTENSITY the amplitude of the pulse and is directly related to perceived sensations; in particular, 3 types of thresholds are distinguished
    1_SENSORIAL when I begin to perceive a stimulus
    2_MOTORIC affects muscle contraction
    3_ABAUT PAIN

Frequency and wavelength are inextricably linked to each other. The higher the frequency the shorter the wavelength. We find this in the application of electromagnetic fields in the treatments we carry out: if our goal is to reach deep down we will use low frequencies, conversely high ones if we want to work on the surface.

Thus, the ELECTRIC FIELD is generated by an electric potential difference (moving electron). The MAGNETIC FIELD is created when an electric current is circulating. The former is measured in V/m the latter in A/m or microTesla which refers to the density of the magnetic field (1 tesla is equal to 10,000 Gauss).

In both, the intensity decreases as one moves away from the source.

THE GAUSS THEOREM the flux through a closed surface is equal to zero since the field lines are always closed and not open as in the electric field. The result is that the poles cannot be split; if we split a magnet we would get only two smaller magnets.

The effect that the magnet gives to everything it encounters in its field is called the MAGNETO-MECHANIC effect, which can also stimulate biological tissues.

PULSED ELECTROMAGNETIC FIELDS are used in rehabilitation, which are very low frequency electromagnetic waves (ULF ELFs) in which the pulsations and sequences of electromagnetic fields stimulate cells to promote their regeneration and do so by promoting ionic currents in aqueous solutions such as cytoplasm. The devices that produce them consist of a metal conductor in coils called a solenoid traversed by variable current. As mentioned above they are very low frequency from 0 Hrtz to 3 KHrtz.

In addition to intensity and frequency, another parameter to evaluate is TIME, given by the WORK CYCLE, which is the ratio of the duration of the active signal to the total period of the signal, i.e., how long does that tissue respond to me to the treatment? In the concept of negative response inhibition, after a time range in which a tissue is subjected to a stimulus it no longer gives a response.

So a magnetic field of adequate intensity affects the orientation of magnetic and paramagnetic substances in our body such as molecular oxygen, metal proteins, and free radicals. These substances tend to align in the direction and direction of the magnetic field. And they stimulate the replication of cellular mitosis.

When there is trauma in the cell, the membrane potential is altered with internal and external depolarization. This creates microcurrents and activation of all the piezoelectric substances in our body for example silicon and quartz. These microcurrents will allow the opening of calcium channels, resulting in the entry of calcium and production of CALMADULIN protein that is essential in osteoblastic production.

It is well known that motor activity is functional in cases of fractures and injuries, but it is also true that even when immobilized, the bone will still restore itself. This concept can be exemplified by virtue of the fact that one is in the presence of ATTVITA. Lymphatic vessels, blood vessels, and nerves, are subjected to a continuous EXCHANGE of energy with magnetic field formation.

Piezoelectric activity is also given motion through MECHANOTRASDUCTION that mechanism by which cells convert mechanical stimuli into biochemical responses. Our body, a too-perfect machine, at the moment an injury occurs sets in motion a process of self-repair generated by the INJURY CURRENTS, which give rise to this whole pathway of cellular activation.

Other biological effects include.

- Decrease in blood viscosity
- Increased metabolism by 30%
- Increased activation of red blood cells
- Acceleration of microcirculation

This represents the clearest example of piezoelectric activity and activation of injury currents in bone fractures: the magnetic field consists of north and south pole, the electric field of a positive and negative pole. In the case of a fracture, the two bone ends become two poles arranged in the same direction as the electrical induction moves from positive to negative and from negative to positive. In physics it is known that two poles of the same sign repel each other, so this is where the injury currents intervene that depolarize one of the two sides, driving ATP production to which osteogenetic activity will follow. Electromagnetic fields accelerate the tissue repair precess.

But when do we speak then of magnetic SUPERINDUCTION? We have said that varying the flow of the magnetic field in a circuit concatenated with it will result in a faint potential difference. This also occurs in the human body, which when hit by a magnetic field will generate currents with a direction perpendicular to those of magnetic field flow. The intensity of the induced current and thus its effects is proportional to the strength of the magnetic field. THE HIGHER THE MAGNETIC FIELD, THE MORE ENERGY I WILL HAVE. These are the high intensity magnetic fields, with which it is possible to reach 2.5 Tesla (PEMF of good quality reaches 1200 Gauss).

By varying the intensity we determine the therapeutic effect of the magnetic field: with LOW INTENSities we will reach the threshold of sensitivity, with HIGH INTENSities the motor threshold.

The fields of application are multiple finding among its effects net pain relief, but also acceleration of fracture consolidation, myostimulation, reduction of edema, improvement of joint ROM and reduction of spasticity.

Contraindications are Pace Maker and defibrillators, pregnancy and lactation, epilepsy, growth cartilage, fever, acute (24/48 hours) disease, prostheses, coagulation alterations.

The OBJECTIVE of our study, was through high-intensity magnetic fields to reduce pain and edema and recover the strength and mobility of the affected segment and eliminate muscle imbalances produced by asymmetrical loading. The patient was a 33-year-old man operated on for Achilles tendon lesion. Recovery time expected by normal protocol 6 months. We used a high-intensity electromagnetic stimulation device in a physiotherapy procedure of 20 sessions, every three weeks, combining the use of the magnetic field with therapeutic exercise and functional training. Assessments were done at the beginning, after plaster removal, and at the end of treatment.

The parameters used were the Verbal Numerical Ratimg Scale (VNRS), the goniometer, for evaluation of ROM, and the meter, for evaluation of edema.

The peculiarity of this treatment can be detected by the earliness of treatment initiation, in fact, as early as the 7th postoperative day, on plaster appliance.

These are the data we detected.

Results

	VNRS	
	At rest	Max. Range of Motion
Pre-treatment	6	*x*
After cast removal	4	7
Post-treatment	0	1

	Ancle Circumference[cm]
Pre-treatment	36
After 1 Therapy	35
Post-treatment	32.5

	Active/passive left ankle range of motion			
	Dorsiflexion	flanterflexion	inversion	Eversion
Pre-treatment	15/20	25/25	15/15	15/20
Post-treatment	25/30	45/45	30/30	20/20

As shown in the graphs, high-intensity magnetic stimulation helped to prevent muscle atrophy in the immobilization phase as well as through modulation of the right frequencies, pain management without medication. Also through dynamic work in the last rehabilitation phase, myostimulation of the triceps suralis was also possible.

Thus, it is possible to say that the combination of the use of high-intensity magnetic field with therapeutic exercise greatly accelerated the recovery time.