THE ADVANTAGEOUS EFFECTS OF ELECTROMAGNETIC AND INDUCED ELECTRICAL FIELDS IN BONE AND SOFT TISSUE HEALING

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The use of magnetic fields and electricity as clinical treatment modalities has been well documented in the academic and popular press. Their indiscriminate use has lead to many bogus claims and positioned these types of treatments as a cure for all ills.

To establish and confirm their effectiveness in treating and managing specific clinical conditions, many research laboratories have conducted and published basic and clinical studies. In the last two decades work by researchers around the globe has lead to an understanding as to how electromagnetic fields, with their inherent induced electrical fields, interact with and stimulate biological repair processes.

Pulsing electromagnetic fields of 0.2 - 1.7 mTesla, at frequencies < 1khz, have been shown to induce potentials of 1 - 5 mv/cm in living tissues. These potentials are comparable with those created in dynamically deformed bone, cartilage, tendon and structural tissues.

Biological repair processes stimulated by these potentials have been clinically used in the treatment of:

- Psuedoarthrosis
- Delayed / non union of fractures
- Avascular Necrosis of the femoral head
- Chronic Tendonitis of the rotatar cuff
- Ulcers of venous origins

Although these pulsing electromagnetic fields contain a broad band of frequencies, most of their energy exists at the lower end of the spectrum. Despite them coinciding with radio frequencies and microwaves, heating of tissues does not occur since the energy expended is in the range of 10^{-10} w/mm^3. In practical terms a modification of local temperature of < 0.001 °C.

Concern has been expressed repeatedly over the safety of such fields. Prior to being used clinically, animal models have been developed to test the safety of the specific fields.
Both single pulse and repeat pulse burst signals have been evaluated. In the case of signals used clinically, in the treatment of over 100,000 patients no pulsing electromagnetic field triggered abnormalities have been reported.

The safety results from animal studies and controlled clinical trials have been confirmed and expanded by independent laboratories as part of the Federal Drug Agencies requirements imposed on commercial manufacturers of electrical stimulators.

The exact mechanism of how specific electromagnetic fields produce specific biological responses has not been fully explained. What is known is that these fields produce:

Changes in	Through
Mineralisation	changes in cellular calcium content

Angiogenesis	nucleation, elongation and junction formation of micro vessels
Hormone Action	Modification of receptors
Increase in Matric Synthesis (collagen and G.A.G.)	Modulation of messengers Ca^{++}, adenyl, cyclase and C amp
Increased DNA Synthesis	Modification of mitogen responses

When using these fields clinically, a dose response has been determined re treatment time versus time to heal (Fractures and soft tissue injuries).

A treatment time of 10 hours (for bone healing) in 24 hours is believed to be the optimum treatment time. To ensure compliance with this treatment modality patient co-operation is essential. Modern light weight portable equipment has been developed from the original line driven units with their associated paired Helmoltz coils.

The new microprocessor controlled equipment allows complient non-invasive treatment and has been used extensively world wide.

In the treatment of certain clinical conditions, surgical intervention can be indicated. In these cases, electrical stimulation may augment surgery and can be achieved by the use of a direct current implantable stimulator. During the surgical procedure, the cathode of the stimulator is placed in the area where fusion or mineralisation is required. Osteogenesis is achieved by passing a constant direct current through the tissues to a remote implanted anode. Currents of 5 - 30 μ amp have been shown to produce osteogenesis even in the presence of infections.

Using this type of device stimulation starts as soon as the unit is implanted and patient compliance is not an issue.

Direct current stimulators are used successfully to treat
- non union of fractures
- Avascular Necrosis of the femoral head
- fuse spinal vertebra

The use of pulsing electromagnetic fields and direct current stimulators in Orthopaedics is not a replacement for good fracture / surgical management. Their roles are to stimulate the biological sequences necessary to repair recalcitrant clinical conditions.

They have been shown to be effective as an alternative to further surgery or can be used as an adjunct to planned surgical intervention.

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