EFFECT OF LOW FREQUENCY ELECTROMAGNETIC FIELD ON THE BLOOD CIRCULATION

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Low frequency, low intensity magnetic energy has been employed by European investigators for treating chronic pain secondary to tissue ischemia and slow healing and non healing ulcers with satisfactory to excellent results. Low frequency, low intensity electromagnetic energy has also been used for treating congenital and acquired pseudarthroses and non union fractures. This type of energy appears to affect biologic process, not through heat production, but through electrically induced changes in the environmental of cells within the organism.

During the last decade and in more than 16 countries, more than 1,000 patients with acquired non unions have been thus treated with an overall success rate over 80%. This method of treatment was approved in 1979 as safe and effective by the Food and Drug Administration for the treatment of non union, failed union and congenital pseudarthroses.

The proposed basic pathological mechanism underlying these orthopedics problems include vascular insufficiency, disturbance of neural tissue and function, etc.
The therapeutic effects of electromagnetic energy have been attributed to increased vascularisation, improvement of tissue oxygenation and/or nerve regeneration.

The effects of low frequency electromagnetic energy on the peripheral blood circulation have been studied in our laboratory. The equipment used in this study was a Biopulse system designed and fabricated by Elec GmBh, division of Magnetopulse Inc, West Germany. The Biopulse system consists of an electrical impulse generator and a circular magnetic coil of 50 cm in diameter providing a magnetic field with a maximum intensity of 100 Gauss and maximum frequency of 50 Hz. In this study, the range of intensity and frequency were 5 to 20 Gauss and 2 to 20 Hz, respectively.

Twenty six subjects with age ranged from 12 to 65 were studied. Blood velocity was determined using model 806 directional Doppler blood flow meter (Parks Electronics Lab, Beaverton, Oregon, USA). The ultrasound probe was placed over the skin above radial artery. Blood pressure and pulse rate were monitored by Led digital electronic monitor, with cuff placed over the brachial artery.

The results are summarized as follows:

1- No significant changes of blood velocity or blood flow were demonstrated when magnetic field was exposed to the chest or head area with a frequency of 5 Hz or less. In 25% of the subjects, a slight increase of blood flow varying from 50 to 120% above the baseline was noted when the pulsating frequency was set at 10 Hz.

2- Significant increases of blood flow were demonstrated in 90% of the subjects when the frequency was set between 12 and 20 Hz. 60% of the subjects gave 200 to 400% increases of blood flow when the frequency setting was 12 Hz. 40% of subjects had the maximum increase of blood flow with frequency of 15 Hz. And 20% of subjects gave the maximum increase at frequency of 20 Hz.

3- The best response was obtained with an intensity of 5 Gauss. When the intensity was set at 10 to 20 Gauss or higher, the results were much less reproduc ible.

4- In 42 testing, no changes in blood pressure and pulse rates were noted during or immediately after the experiments, In 45 testing, a slight increase of blood pressure and pulse rates were noted during the experiment when a magnetic field was on. In 12 testing a slight increase of blood pressure and pulse rates was noted. These changes were not statistically significant, however.

The conclusion of this portion of study is low frequency, low intensity magnetic field increased blood flow in the great majority of the subjects we tested. This increase was not due to increase of blood pressure or heart rate. Since the blood flow is directly proportional to blood pressure and indirectly proportional to the resistance, namely:

BLOOD FLOW = BLOOD PRESSURE/RESISTANCE

We can thus conclude that the increase of blood flow at radial artery was the result of decrease of peripheral resistance. This decrease of resistance was brought about most likely by dilation of arterial vasculature.

Our second part of the study was carried out with Servomed oxymonitor model 361 (Hellige GmBh, West Germany) for monitoring transcutaneous oxygen partial pressure. This study has been performed on 64 human subjects. The transcutaneous electrode was placed on the volar surface of the forearm or palm with the electrode temperature set at 43C. The baseline oxygen partial pressures of our subjects at these sites were in the range of 15 to 45 Torr. With magnetic frequency of less than 10 Hz, the majority of subjects showed no changes in the oxygen partial pressures. In 40% of the subjects, a decrease in oxygen partial pressure was actually noted. When the frequency was set at 12 to 20 Hz, an increase of oxygen partial pressure from 1 to 4 folds was demonstrated in 90% of our subjects. In the majority of the subjects, this increase was gradual, reaching the peak in 10 to 15 minutes, the increase usually persisted for a period of several hours. In 15% of the subjects, a sharp rise of oxygen partial pressure reaching a peak in two to three minutes was demonstrated. The persistence of this rise of oxygen partial pressure was again demonstrated.

Conclusions: This study demonstrates that low frequency, low intensity electromagnetic field increased blood flow of human subjects. This increase of blood flow was not due to increase of peripheral blood pressure or heart rate. It was implied that the increase of peripheral vascular resistance secondary to dilatation of the blood vessel. The increase of oxygen partial pressure in the skin of hand and forearm from one to four folds in the subjects we tested further substantiates this finding. It would thus seem that the low frequency, low intensity electromagnetic energy may be beneficial in clinical conditions where increase of tissue oxygenation is specifically desirable.