ANALYSIS OF THE EFFECTS OF PULSATING ELECTROMAGNETIC FIELDS ON A PARKINSONIAN PATIENT USING PHOTOPLETHYSMOGRAPHY.

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ABSTRACT

Applications of pulsating electromagnetic fields, (PEMF) have effected positive changes in various disease groups. Initial studies involving a 73 year old Parkinsonian subject were done with PEMF applied over the whole body using the Quantronic Resonance System Photoplethysmographic recordings were taken at the beginning, midway and at the end of the therapy period as a means of quantifying any changes occurring.

Preliminary findings indicate an improvement in the blood volume pulsation and the degree of blood oxygenation measured at the finger site after a 39 day therapy period. In addition measurable changes in the amplitude spectra of the traces were observed. The motor responses of the patient also improved considerably as a result of the therapy.

INTRODUCTION

The use of electromagnetic fields, EMF, in medical practice is not new. Short-wave and microwave diathermy treatment have been successfully used for many years in relieving pain, and x-rays and magnetic resonance imaging are some of the many applications of electromagnetic radiation used in diagnostic medicine (WHO, 1993) In addition numerous patented devices currently exist which produce time-varying electromagnetic fields of different frequencies, power rating, pulse duration and repetition.

The 223-23 pulse cycles/sec are repeated with a rhythm of 3 times per second. The coils of the Quantronic Reasonance System, which are positioned against the body, also reach the brain when using this rhythm as a result of which specific calming effects are triggered.

This 223-23-3 pulse cycle is then stopped for a short time (approximately at the same rhythm as the heart beat) to prevent the neurons from getting accustomed to the cycle. The special frequency of the particular effective low field amplitude of the Quantronic Resonance System results, together with the ambient, roving magnetic and electric fields (electromagnetic smog) in a beat of the combined fields at 2 to 3 strokes per second. This combined field elimates the 'poisonous' effect of the smog.

The therapy time per treatment is automatically limited to 8 minutes. In this time the direction of the magnetic field force vector is automatically reversed every 2 minutes in order to achieve a uniform effect throughout the body (Fischer)

The magnetic field vector produced by the system sets up an orthogonal induced electric field acting in phase. This encourages ion movement in a particular direction, which in turn triggers off numerous therapeutic forces. It is this process which provides whole body stimulation targeting specifically the cardiovascular and neurovascular systems of the subject undergoing therapy (Fisher)

Pulsed electromagnetic fields, PEMF, have far varied applications. Numerous authors have used them in the treatment of many types of ulcers such as plantar ulcers (Raghupati et al., 1997) decubitus ulcers (Comorasan et al., 1993) and venous ulcers (Kenkre et al., 1996: Stiller et al., 1992) Treatments for osteoarthritis (Trock et al., 1993) sleep inducing effects (Reite et al., 1994) tinnitus (Roland et al., 1993) and wrinkles (Teofoli et al., 1994) are also included in the literature. Warnke (Warnke 1988, Warnke, 1989) applied PEMF to the head and thorax of subjects and observed dilation in the blood vessels. Amplitude and frequency modulation of the field produced changes in circulatory parameters. PEMF have also been extensively used in the treatment of migraine. (Sherman et al., 1998) multiple sclerosis (Sandyke, 1995) and Parkinson;s disease (Sandyk, 1994 Sandyk, 1997)

The latter application was of particular interest to our research group. However since the existing literature did not quantify changes which may have occurred in the cardiovascular and neuro-vascular systems of Parkinsonian patients, the use of a non invasive monitoring device, photoplethysmography which provides semi-quantitative assessment was considered for this task. The technique involves the backscatter of near infrared and red electromagnetic radiation from the skin. The conversion of the intensity of the backscattered radiation into an electrical signal passed into an analog-digital converter and then to an IBM compatible computer, gives rise to a characteristic trace. This trace is representative of the blood volume pulsation and the total blood volume flowing through the skin at that particular time (Kraus et.al., 1997. Grohmann et al., 1996b, Grohmann et al., 1996a)

NIRP

Near Infrared and red photoplethysmography, NIRP, was used to penetrate the dermal layer of the finger and toe of the patient. Pulsed light of mean power 1.25mW is used. The infrared light, 840 nm, gives an indication of the total blood volume under the sensor while the red light, 640 nm, gives a relative measure of the volume of oxygenated blood at the site. The CMMD, Computerized Micro and Macro Diagnostics program provides analysis of the traces obtained. The sensor, light emitting diodes and a temperature probe are all located in a clip which can be attached to the finger or the toe (Krauß et al., 1997, Krauß et al., 1996, Grohmann et al., 1996b, Grohmann et al, 1996a. Christ et al., 1995)

Experimental Protocol

Pulsed electromagnetic field therapy was provided to the patient for a total of 39 days. For the first 20 days of therapy the patient was provided with 8 minutes of PEMF at level IIIb(setting 5, 6), three times daily at 8.00 am. 1.00 pm, and 8.00 pm. From day 21, the treatment remained the same except that at 8.00 pm, Level IIIc(setting 3, 4) was used instead of Level IIIb. This was intended to promote more restful sleep.

The patient was made to lie in a supine position on the mat with her head just of the top edge. The field was switched on for 8 minutes after which time it was automatically turned off. The patient was instructed to remain in a supine position for at least ten minutes after the end of therapy.

Pholoplethysmographic recordings were made on day 5 of therapy, day 20 and on day 40. The patient was made to lie in a supine position for about five minutes for stabilization of the cardiovascular and neuro-vascular systems. The finger clip containing the light emitting diodes and the sensor was attached to the finger and the patient was instructed to relax and breathe normally. Two 70 second recordings were taken to ensure reproducibility. The patient was then instructed to breathe deeply and again two recordings were taken. The procedure was repeated with the clip placed on the big toe. With the clip still attached in the toe, the right hand was immersed in cold water and a recording made for 70 seconds. On the third day of recording, 5 minutes after this measurement, the previously immersed hand was warmed manually and systems allowed to re-equilibrate. The procedure of cold water limb immersion was then repeated with the finger as the recording site.

RESULTS

Qualitative

The patient kept a daily record of her condition during the therapy period. She generally felt better after each therapy session. In addition she experienced more restful sleep at night. Then, when the setting was switched to level IIIc at nights she was able to sleep one hour longer than she usually did. The patient also reported that she was more adept in rising from a sitting position and also was able to walk easier than before. She noted that these improvements were generally within one hour after each therapy session.

Quantitative

The figures below (Figs. 1 a, b, c) show the blood volume pulsation recorded from the finger on days 5, 20 and 40 of thereapy from the near infrared wavelength. There was less noise in the signals as the number of days of therapy increased. There was better resolution on day 40 when the individual pulses seemed more clearly defined than the two previous occasions. The amplitude of the pulses also increased over the therapy period using the same amplification each time. Since the area under each pulse represents blood flow, it is clear that the circulation of the blood in the microcirculation improved with the PEMF therapy.

Traces were also made with the toe as the recording site. There seemed to be "better" traces obtained in these series of measurements as compared to the finger. This indicates that the circulation in the lower extremities was better than that in the upper extremities (Figs. 2 a, b, c) This trace did not change significantly over the recording period.

Figs. 3 a, b give an indication of the degree of oxygenation of the blood flowing under the recording site. At the end of the therapy session the trace obtained was more pronounced than that recorded at the beginning of the therapy. In fact there were distinct pulses at the end of therapy compared to the trace at the beginning of therapy, which was almost linear.

In order to investigate the state of the neuro-vascular system, the left hand was immersed in cold water while a recording was made from the right hand. In normal subjects there is evidence of vasoconstriction by diminished amplitude in the trace after limb immersion. In this instance, this response was only evident in the NIRP recording at the end of therapy, with the finger as the recording site (Fig.4) There was also a slow overriding wave associated with this trace. This is probably due to a change in the state of the autonomic nervous system as a result of PEMF therapy.

CMMD analyses the frequency components associated with the raw traces of the blood volume pulsation by means of fast Fourier transform. Each frequency component is depicted on the amplitude spectrum, and relative to the heart rate, its percentage abundance is shown (Figs, 5 a,b,c) (Krauß et.al., 1997: Grohmann et al., 1996b, Grohmann et al., 1996a: Chrisi et al., 1995)

In the trace obtained on day 5 of therapy, the heart rate was 87/min (Fig 5a). This value changed over the therapy period to 92 and 91/min on the other two recording days (Figs 5b, 5c). These values are shown as those lines with the highest amplitude in the figures below. These values lie out of range of the normal heart rate of subjects represented by the small horizontal line at the top of the diagram.

There was also evidence of low frequency components, associated with all three traces. However the relative abundance of these components diminished progressively over the recording period with values of approximately 65%, 50% and 30% respectively. (Figs 5a, b and c). At the end of the therapy period, these low frequency components were more evenly distributed than on the two previous recording sessions. These frequencies are generally too low (less than 0.1 Hz) to be associated with the normal breathing frequency of approximately 0.283 Hz.

On the other extreme, there is also a very high frequency component in the range of 7 Hz associated with the waveforms. On the first recording day, the components were more abundant than on the other days.

The normal range of harmonics associated with amplitude spectrum given by the CMMD program is either displaced or absent in these traces.

SUMMARY

Pulsed electromagnetic fields used by Sandyk (Sandyk, 1997, Sandyk 1994) have been shown to improve the response to Levodopa in Parkinson's disease and generally improve the cognitive and motor abilities of patients studied. Although the improvements in the motor abilities of our patients were not as pronounced as those itemized by Sandyk, this can probably be attributed to the much shorter therapy period used. In our study the inability of the patient to get on and off the bed without assistance curtailed the therapy period to a 5 week duration while in Sandyk's study it was 10 weeks long.

In spite of this however the technique of photoplethysmography was able to discern changes in both the blood volume and the degree of oxygenation in the peripheral vessels with improvements in both instances. The amplitude spectra computed from the three days of recording also exhibited pronounced changes. Whether these changes were local or long term is still being debated. However the change in the traces obtained during cold water limb immersion is definitely an indicator of some response in the autonomic nervous system as a result of whole body application of PEMF. Further quantitative analysis using the CMMD program was not possible due to the poor quality of some to the traces recorded.

Further studies will involve other patients with Parkinson's disease, therapy being administered over a longer period. The use of photoplethysmography to provide quantitative assessment will also be incorporated in these studies. A control group and placebo treatment is also required to justify findings although the preliminary results obtained in this study indicate that the effects of PEMF on Parkinsonian patients are pronounced and measurable.

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