MULTIFUNCTIONAL SYSTEM FOR PHYSIOTHERAPY

Atanas Dimitrov*, Sasho Guergov**, Dimiter Tz. Dimitrov*

Faculty of Telecommunication*, Faculty of Industrial Technology**,
Technical University - Sofia,8, "Kliment Ohridsky" str., 1000 Sofia,Bulgaria,

Abstract

An investigation on structure of one multifunctional adaptive system for physiotherapy with measurement devices has been done in the paper. In the paper there are descriptions of different parts of the multifunctional system. Some characteristics and properties of different units of multifunctional system have been done, also. Some possibilities for simultaneously applications of different system's units are described, also. It's important to provide simultaneously application of different system's units only when their physiological influences on the human body are compatible. Simultaneously application of magneto-therapy, mechanical acupressure and cranial electro stimulation are described in the paper.

1. INTRODUCTION

There are many well know methods for physiotherapy, which can be applied in different cases of pathology. Often according to these methods there is a separate "hard" application of different external influences one by one. One new tendency in medicine is connected with application of multifunctional adaptive systems for physiotherapy. These systems can provide not only separate influence of different external influences, but simultaneously influence of these external influences of on one or on different part of the human body. Some times a physical interaction between these external influences can be seen as in the case of simultaneously influence of low frequency electrical and magnetic fields. In other cases there is not formal physical interaction between external influences, but there is physiological interaction as in the cases of simultaneously influence of low frequency magnetic field and acupressure or acupressure and Cranial Electrotherapy Stimulation (CES). CES is the application of low-level pulsed electrical currents (usually less than 1mA) applied to the head for medical and/or psychological purposes. It would be very convenient for physicians if much more units for different external influences would be available as parts of one multifunctional adaptive system for physiotherapy. For instance this system can provide influence of low frequency magnetic field, low frequency electrical field (including Cranial Electrotherapy Stimulation) and acupressure.

2. DESIGN OF DEVICES FOR CREATING OF LOW FREQUENCY MAGNETIC FIELD

The application of China's method for acupressure is very actual in medical therapy, now. Usually physician provide application of acupressure by his hands. It's inconvenient first of all for physician. He's able to work for short time. Then he can continue after relax, but the number of these procedures per day are limited. In other side it would be better to provide acupressure simultaneously on more points on the human body. It's impossible because physician has only two hands.

The results of therapy by acupressure would be more good if there would be provided more intensive movement of the blud in around the points of acupressure. This activation of blud's movement can be provided by application of low frequency magnetic field together with acupressure.

It's clear that it' s necessary to provide special device for acupressure, which can be used together with special device for creating of low frequency magnetic filed around the points for acupressure. Therefore the application of system for simultaneously application of acupressure and low frequency magnetic field is very actual, now.

Usually the low frequency magnetic field can be created using two coils, connected to the output of apparatus for magneto-therapy. This apparatus is a source of special electrical signals for the coils.

Often the application of above described method for therapy is on the hand because there are situated many points of acupunctures.

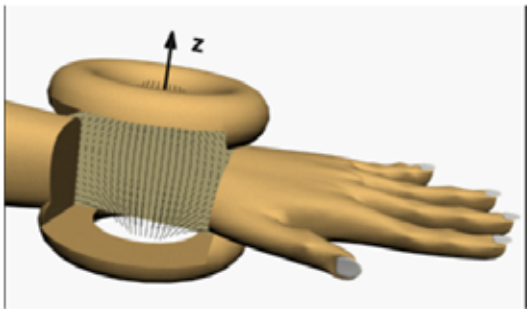

Fig. 1. A possibility for disposition of two coils on the hand

The space configuration of the lines of vector of magnetic induction can be seen on fig. 1.

It's well known that on the *spine* there are many points of acupuncture, also. Some examples for disposition of coils on the spine can be seen on fig. 2.

The axis of space components of magnetic induction of magnetic field, created by different coils can be seen on fig. 2, also.

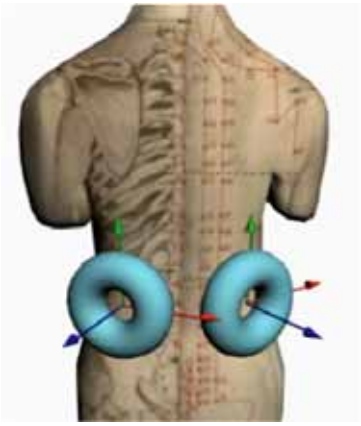

Fig. 2. Some examples for disposition of coils on the spine

A girdle coil (fig.3) can be used for magneto-therapy, also.

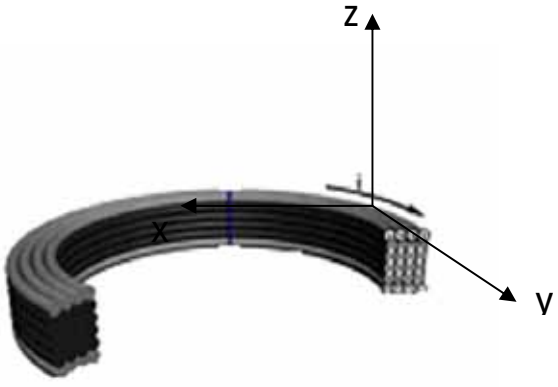

Fig. 3. A girdle coil

3. MEASUREMENT OF PARAMETERS OF LOW FREQUENCY MAGNETIC FIELD

First of all it's important to provide measurement of the value of magnetic induction in the process of magneto-therapy. The sensor has been putted in different points around the girdle coil. The measurement of the gidle coil's current has been done by ordinary ampermeter. The measurement of module of magnetic induction on the axes X and Z (Fig. 3) has been done. The results of experimental measurements together with the results of calculation of the module of magnetic induction on axis X can be seen on Fig. 4.

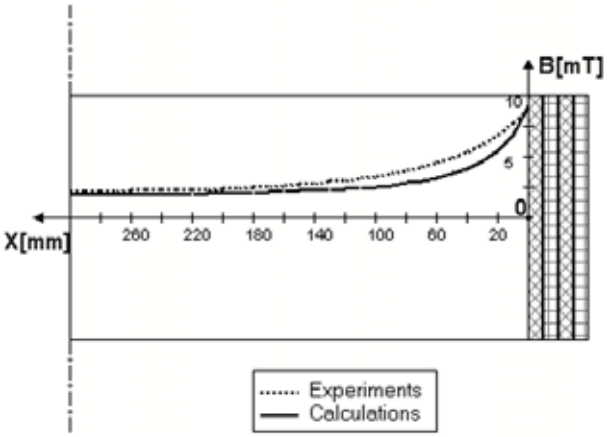

Fig. 4. Module of magnetic induction on the axis X

The results of experimental measurements together with the results of calculation of the module of magnetic induction on axis Z can be seen on Fig. 5.

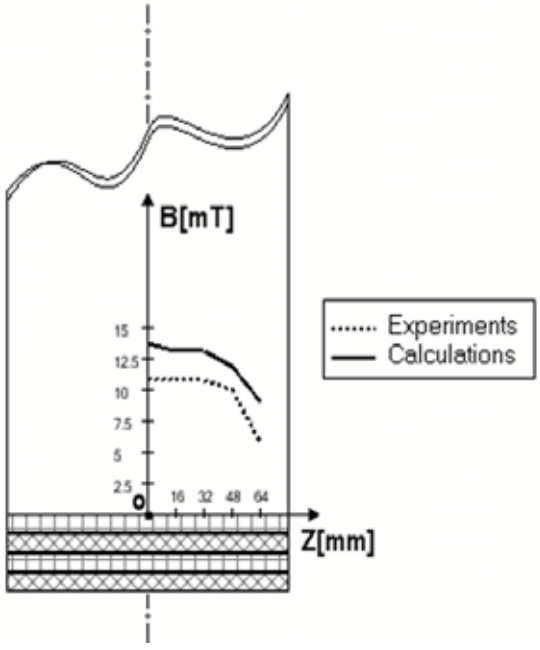

Fig. 5. Module of magnetic induction on the axis Z

4. LEVEL OF ERRORS OF MEASUREMENT OF THE VALUE OF MAGNETIC INDUCTION

The main causes for errors between calculated and measurement results are: the finite sizes of the sensor. The results of calculation and results of experimental measurements are similar. It was the main goal of investigation. Of course it's possible to obtain more precise methods and measurement devices, but it's not necessary in the case of magnetotherapy, where usually the values of magnetic induction are 10-30 mT and 10% error is acceptable. It's clear that only one small translation of the human body in the girdle coil would be enough for an error of the value of module of magnetic induction in an arbitrary point of the human body, more than 10%. The value of relative magnetic permeability of live tissue $\mu_r \approx 1$ as in the air.

Therefore computer simulation can be used successfully for future investigation of space configuration of low-frequency magnetic field in the human body, also. This is the main conclusion of the above investigations.

5. DESIGN OF DEVICES FOR CREATING OF CRANIAL ELECTROTHERAPY STIMULATION

Often, in the last time there is application of therapy by acupressure simultaneously with electrotherapy especially with Cranial Electrotherapy Stimulation. Usually physician provide application of acupressure by his hands and he should be very careful because this therapy is on head. Of course it's possible to be used separately one by one both therapy by acupressure and Cranial Electrotherapy Stimulation, but the effect of therapy especially effect of relaxation would be more good in the case of simultaneously application.

Sometimes in the cases of high values of the blood pressure, stress and loss of the sleep physicians use successfully a unit for magneto-therapy for decreasing of blood pressure and Cranial Electrotherapy Stimulation for sleeping using an other unit for electro-seeping. In the last time often physicians use both magneto-therapy and electro-sleeping simultaneously. This allow them to obtain more good effect of therapy. The method of Cranial Electrotherapy Stimulation is new one since the end of last century. Therefore some preliminary separate investigation of this method has been done before simultaneously application of the method together with magneto-therapy or/and acupressure.

CES treatment may result indirectly in increased blood flow to the brain. Hence its possible contra-indication in recent hemorrhagic stroke patients. This same effect can cause brief increased blood flow beneath the electrodes behind the ears. This redness should not be cause for concern. This is an extremely rare occurrence. Cranial electrotherapy stimulation devices are generally similar in size and appearance to standard transcutaneous electrical nerve stimulators (TENS), but produce very different waveforms. Standard milliampere-current TENS devices must never be applied transcranially. CES electrodes can be placed bitemporally, bilaterally in the hollow behind the ears just anterior to the mastoid processes, or clipped to the earlobes. This depends on the device being used. Most CES devices should produce a pulse repetition rate (PRR) of 100 Hz.Some produce a PRR as low as 0.5, or as high as 15,000 Hz. Most CES units are user friendly. After having put on either the electrodes or the ear-clips and inserted the lead wire into the jack, it's all very simple. CES units either feature an on-off knob that also controls the amplitude (turning it to the right increases the amount of current) as in the 100 Hz devices. A CES generates an adjustable current of 80 to 600 μA that flows through clips placed on the earlobes. The waveform of this device is a 400 milliseconds positive pulse followed by a negative one of the same duration, then a pause of 1.2 seconds. The main frequency is 0.5 Hz, i.e. a double pulse every 2 seconds. Current output is limited to 600 μA max and can be regulated from 80 to 600μA. A LED can flashes every 2 seconds signaling proper operation and can also be used for setting purposes.

A common CES configuration is 100 Hz with a maximum current output of 1.5 mA, current amplitude similar to that in the human body. A device of CES as part of multifunctional system for physiotherapy can be seen on fig. 6.

Fig. 6. Device for Cranial Electro Stimulation

6. DESIGN OF MECHANICAL DEVICE FOR ACUPRESSURE

The design of mechanical devices for acupressure should be connected with design of coils for magneto-therapy as the multifunctional system should provide simultaneously application of acupressure and magneto-therapy. It's well known that magnetic filed can increase the velocity of ions of blood. Because of that the effect of acupressure can be more good. Usually the line of mechanical pressure is the axis of coils. The sizes of coils can be different according to the sizes of "active" area around of the acupuncture points.

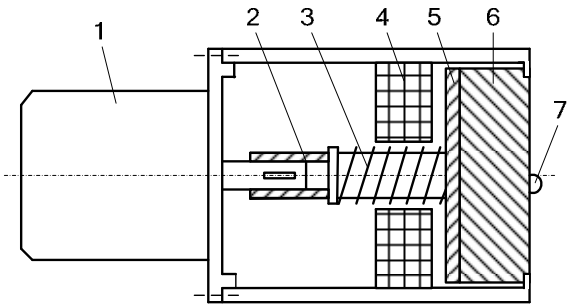

Fig. 7. Mechanical device for acupressure

On fig. 7 can be seen a mechanical device for acupressure, when:

1 – motor;
2 – axle;
3 – shaft;
4 – a coil, which provides axial movement of the shaft;
5 – metal disk;
6 – plastics body;
7 – massage pimple (osezatel).

The modified device for acupressure simultaneously with low frequency magnetic field can be seen on fig. 8. It can be seen that the shaft is in the coil for magnetotherapy.

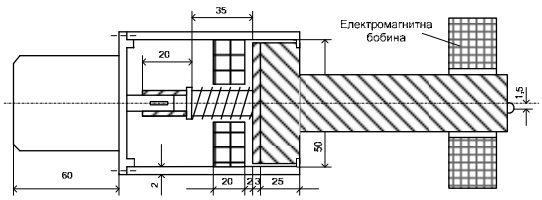

Fig. 8. Modified mechanical device for acupressure simultaneously with application of low frequency magnetic filed

7. CONCLUSION

1. It's clear that the process of physiotherapy can be more effective in the case of simultaneously application of several unites (apparatuses or/and devices) for different physical influences on the human body than separate application of these unites one by one.

2. The big advantage of one multifunctional system for physiotherapy is that it's flexible and user friendly. Therefore it's easy to be obtained different configuration of system and to provide applications of many methods for physiotherapy. Because of that the system is adaptive to medical methods for therapy.

3. Usually every multifunctional system can be developed easy. It's enough to add new units which should be compatible with the rest system's units.

The use of footnotes is discouraged. Include necessary secondary explanations in the text (within parentheses) if you need additional comments.

References

[1] Kirsch, D.L. and Smith, RB. The use of cranial electrotherapy stimulation in the management of chronic pain: A review. NeuroRehabilitation 14 (2000) p.85-94.

[2] Winick, R.L. Cranial electrotherapy stimulation (CES): a safe and effective low cost means of anxiety control in a dental practice. Gen. Dent. 47 (1999) p. 50-55.

[3] Lichtbroun, A.S., Raicer, M.C. and Smith R.B. The treatment of fibromyalgia with cranial electrotherapy stimulation. J. Clin. Rheumatol. 7 (2001) p.72-78.

[4] Hozumi, S, Hori, H, Okawa, M, Hishikawa, Y and Sato, K. Favorable effect of transcranial electrostimulation on behavior disorders in elderly patients with dementia: a double-blind study. Inter. J. Neurosci. 88 (1996) p.1-10.

[5] Southworth, S. A study of the effects of cranial electrical stimulation on attention and concentration. Tntegr. Physiol. Behav. Sci. 34 (1999) p.43-53.

[6] Schroeder, MJ and Barr RE. Quantitative analysis of the electroencephalogram during cranial electrotherapy stimulation. Clin. Neurophysiol. 112 (2001) p. 2075-2083.