Analysis of Pulse Wave during Magneto-Therapy Session

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Abstract— **The aim of this study is to highlight the influence of the therapy with magnetic fields of low-frequency on the human body through the evaluation of the hemodynamic parameters during this type of physiotherapy sessions. Theraphy using low-frequency magnetic fields is one of the procedures of physiotherapy which brings a lot of benefits to the patients and in this paper work we have demonstrated that there is a considerable influence on the circulatory system. In a low-frequency magnetic field, blood circulation to the patient improves, the elasticity of the vessel walls is increasing, and the concentration of oxygen in bloodcells increase with 200%.**

Keywords— **monitoring biomedical parameters, magnetic theraphy, hemodynamic circulatory**

I. Introduction

The energy from magnetic fields used for therapeutic took a tremendous impetus nowadays, which is felt worldwide. Magneto-therapy is a form of physical therapy that uses low frequency magnetic fields energy, noninvasive, being an effective remedy for treating a wide range of rheumatology and beyond.[1]

The principle behind this therapy is that some cells and tissues in the body presents electromagnetic pulses, which in the case of diseases or disorders degrades. Magneto-therapy works by producing different levels of magnetic fields that can penetrate the human body, having healing powers on him.[2]

Monitoring of cardiovascular parameters during magneto-theraphy session can provide information particularly helpful to personalize medical treatment.[3]

II. Study objectives

The evaluation of patients during magneto theraphy session by monitoring biomedical parameters aims to detect changes in functional status of the subject, and the activity of the human body in the electrical, mechanical and magnetic fields.

By measuring hemodynamic parameters we can obtain useful clinical information about cardiovascular function of the body.

Currently, this method of improvement and healing of diseases attracted the attention of specialists, and the studies in this area has intensified proving real qualities of magnets theraphy. However, research towards healing effects of magnetic therapy is still in the early stage. The reason behind the choice of the theme was the desire to bring more studies dedicated to magneto theraphy and its effects on the body.

The monitoring parameters during magneto theraphy session aims to highlight the influence of low frequency magnetic fields on human body by evaluating hemodynamic parameters during this physiotherapy procedure.

Hemodynamic studies referes to the factors that maintain, modify and regulate the movement of blood through the circulatory sistem.

Blood flow (Q) is a fundamental hemodynamic parameter, which is the volume flowing ($\triangle$ V) through the unit time (t) in section (D) [3]:

$$Q = \triangle V / D*t \quad (1)$$

The flow rate is a derived parameter, represented by the cross-sectional area relative to the volume flow [3]:

$$v = D / S \quad (2)$$

The structural and functional large arteries are vessels to be conductive, while arteries and arterioles are resistance terminal vessels. In turn, the veins are vessels through which blood circulates capacitive under low pressure. Regardless of the vascular territory, the movement of blood through the blood vessels is determined by two main factors.

The difference pressure between the two ends of the vessel (P1 and P2) as the biasing force and displacement of the blood by the pressure within the high to the low pressure;

Many staff who resists blood flow, called vascular resistance.

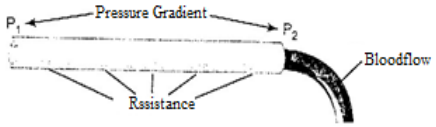

Fig.1 The expression of vascular resistance [3]

P1 is the pressure of blood vessel origin; at the opposite end, the pressure is P2. Resistance occurs due to the friction between the bloodstream and the intravascular endothelium over the entire inner surface of the vessel. The flow through the vessel can be calculated using the formula [3]:

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$$F = Ap / R \text{ (Ohm's law)} \quad (3)$$

F is the blood flow, Ap is the pressure difference (P1-P2) between the two ends of the vessel, and R is resistance. This formula is in effect saying that blood flow is directly proportional to the pressure difference, but inversely proportional to resistance.

It is very important to remember, that the pressure difference between the ends of the vessel, is not absolute pressure in the vessel, which determines the flow rate. For example, if the press-united at both ends of the vessel is 100 mm Hg, and there is no difference in pressure between the two ends of vascular, there will be no flow though a pressure of 100 mmHg. [4]

When the body is under the influence of a magnetic field, blood flow increases and the oxygen is absorbed into the tissues. This is probably one of the mechanisms that helps in healing and one of the reasons why it is helpful in so many different diseases.

III. Results

Magnet has a great influence on our organism, this being discussed and analyzed in numerous documents and publications. The research made so far to make a statement that there is a series of variations in the human body signals during magneto-theraphy session are highlighted by various records during this procedure, and photoplethysmography is one of the body signals who helps as to get information from the circulatory sistem. For a more accurate assessment of biosignals obtained from the pacient in this study we have decided to record the photopletysmography before, during and after magneto-theraphy session.

Venue of research is the Department of Medical Rehabilitation from the Hospital CF, Iaşi, department specialized in all new methods of recovery and physical medicine,.

Magneto theraphy is the physiotherapy procedure chosen for research. During this procedure we monitored the blood flow parameters in patients that received therapy with low-frequency magnetic fields due to their diagnosis of diseases including the treatment procedure.

The device for magneto theraphy used in our study is a product of Romanian origin, and consisting of two solenoids and two inductors coil that blur associated with the following parameters:

Commonly 50Hz;

Intensity fixed: - 4 mT for cervical coil;
- 2 mT for lumbar coil;
- 20 to 23 mT for locating coils.

The effects of therapy with low-frequency magnetic fields device are:

-to continues unmodulated form: sedative, sympathicolitic, trophotrope;

-to interrupted form: excitatory, sympathicotonia, ergotrop.

The patient is placed in a comfortable position (supine) on parallelipipedal component and placed in the magnetic field by placing the coil with diametrically di largest in the lower limbs. Jewelry and the metal objects are removed from the patient.

Fig. 2 The position of the pacient in the magneto-theraphy device

Duration and stages of research

For research we monitored during the magnet therapy procedure 37 patients with different diagnoses, in several days (the monitoring was in at least one day and up to six days).

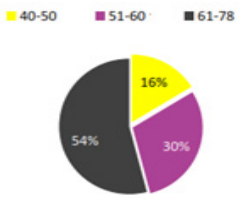


Fig. 3 Age repartition of the patients

For each pacient we recorded the biomedical signals using photoplethysmography before, in time and after the magnto-theraphy session, obtaining a PPG (photoplethysmogram) and a APG (Acceleration PlethysmoGram) wave form.

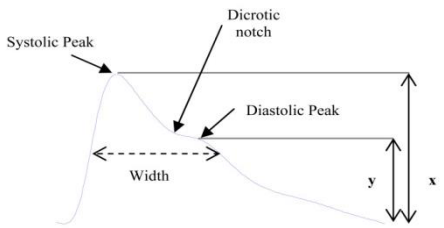


Fig. 4 A typical waveform of the PPG and its characteristic parameters, whereas the amplitude of the systolic peaks is x while y is the amplitude of the diastolic peak [5].

There are different types of APG waveforms. The first APG waveform A (far left) refers to good circulation, whereas the amplitude of B wave is lower than C wave. The

last APG waveform G (far right) refers to distinctively bad circulation, whereas the amplitude of C wave is lower than B wave [5].

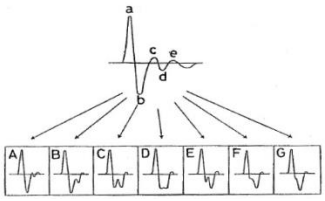


Fig. 5 APG waveforms and types of photoplethysmogram [5]

After collecting all necessary data we have made an analysis of results and graphical method was used to highlight more clearly the level of every patient and its future evolution.

Most indices are based on the second derivative of the finger photoplethysmogram (APG) which seems to provide more information than the first derivative of PPG. The indices calculated from the APG waveforms can be correlated with the distensibility of the carotid artery, age, the blood pressure, the estimated risk of coronary heart disease, and the presence of atherosclerotic disorders

By interpreting the APG form we could decide in which category of hemodynamic risk we can include our pacient. For example in figure 5 we can observe that from the interpretation of APG obtained during theraphy session, the pacient is in a risk category and the blood circulation is getting worse, because the blood pressure is increasing due to the fact that the blood vessels wall narrows.

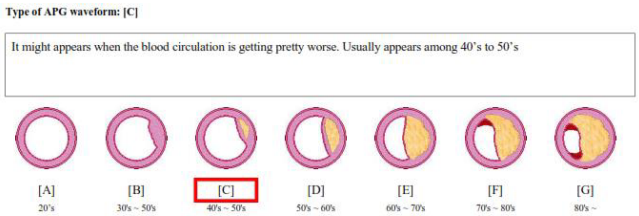


Fig.6 The APG obtained during theraphy session to pacinet A.M.

For each age category we did records, as illustrated in fig.6, fig.7 and fig.8 for wave APG:

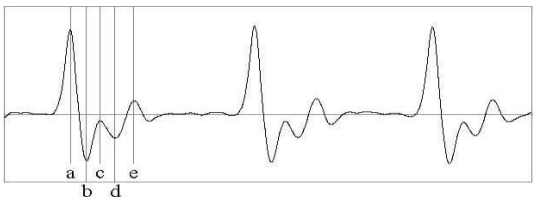


Fig. 7 APG wave for pacients between 40-50 years

Fig. 8 APG wave for pacients between 51-60 years

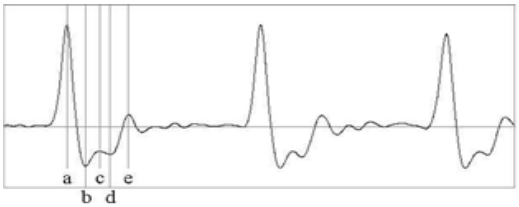


Fig. 9 APG wave for pacients between 61-78years

As we can see from these three graphs, the age of the pacient influences the APG wave form, because the elasticity of the blood vessels is decreasing with age.

For all 37 subjects included in the research, were recorded four individual sheets with daily monitoring of their biomedical parameters that enable better analysis and interpretation of the evolution of each patient during magneto-theraphy and at end of treatment.

The graphical representation of the variation in mean heart rate (HR avg) of the entire group of patients undergoing research:

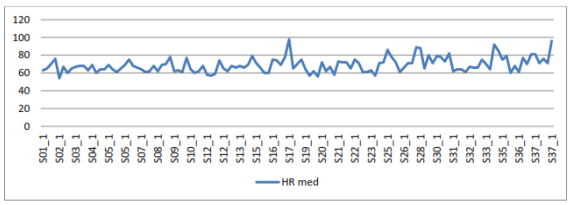


Fig. 10 Change in HR prior magneto therapy session

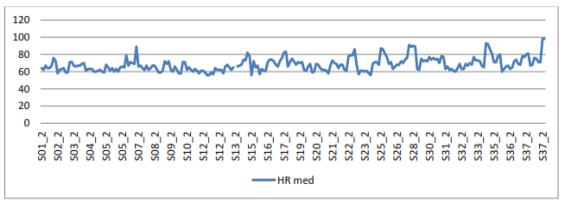


Fig. 11 Change in HR in time of magneto- therapy session

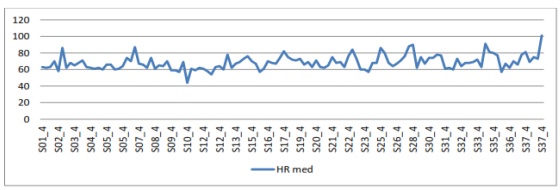
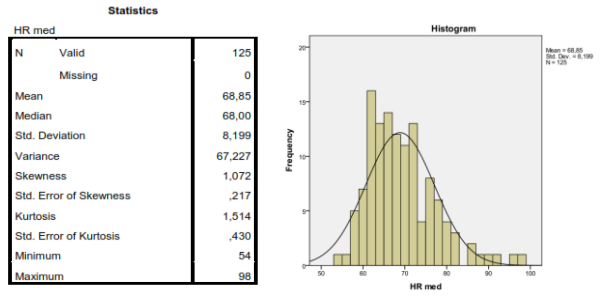


Fig. 12 Change in HR after magneto- therapy session

As we can see from the statistical interpretation of the obtained data, the blood circulation improved, evidenced by regulating heart beat (HR).

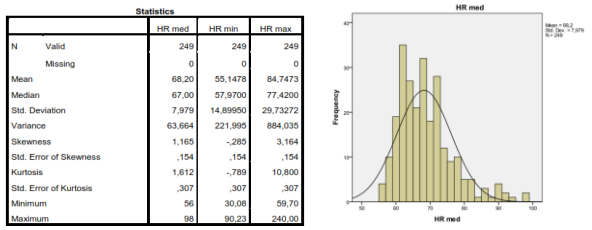


Statistics

HR med

N	Valid	125
	Missing	0
Mean		68,85
Median		68,00
Std. Deviation		8,199
Variance		67,227
Skewness		1,072
Std. Error of Skewness		,217
Kurtosis		1,514
Std. Error of Kurtosis		,430
Minimum		54
Maximum		98

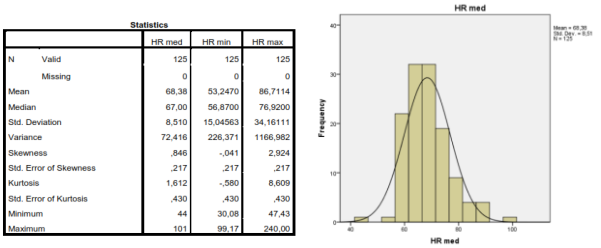
Fig. 13 HR mean before magnetoteraphy session



Statistics

		HR med	HR min	HR max
N	Valid	249	249	249
	Missing	0	0	0
Mean		68,20	55,1478	84,7473
Median		67,00	57,9700	77,4200
Std. Deviation		7,979	14,89950	29,73272
Variance		63,664	221,995	884,035
Skewness		1,165	-,285	3,164
Std. Error of Skewness		,154	,154	,154
Kurtosis		1,612	-,789	10,800
Std. Error of Kurtosis		,307	,307	,307
Minimum		56	30,08	59,70
Maximum		98	90,23	240,00

Fig. 14 HR mean in time of magnetoteraphy session



Statistics

		HR med	HR min	HR max
N	Valid	125	125	125
	Missing	0	0	0
Mean		68,38	53,2470	86,7114
Median		67,00	56,8700	76,9200
Std. Deviation		8,510	15,04563	34,16111
Variance		72,416	226,371	1166,982
Skewness		,846	-,041	2,924
Std. Error of Skewness		,217	,217	,217
Kurtosis		1,612	-,580	8,609
Std. Error of Kurtosis		,430	,430	,430
Minimum		44	30,08	47,43
Maximum		101	99,17	240,00

Fig. 15 HR mean after magnetoteraphy session

IV. Conclusions

Magneto-therapy, is one of the basic pro-cedures on physiotherapy, and brings a lot of benefits to patients who can enjoy this therapy, and as has been observed in our study, the parameters from the circulatory system are modified, and helps on the healing of the pacient.

Photoplethysmography used as an objective method for registration of biomedical parameters has failed to identify magneto-theraphy impact on the human body. APG wave illustrates the changes in hemodynamic parameters during this physiotherapy procedure. This method of biomedical signals recording, enabled better analysis of the impact of this therapy on the human body. Thus we have observed an improvement in blood circulation, evidenced especially by regulating heart rate.

In conclusion, we can say that the therapy with low frequency magnetic fields is a safe, tackle low and surprising benefits for treating various diseases. It is undeniable the influence of magneto-theraphy to human body. Because of the many indications in a wide variety of diseases and the few contraindications, magnet should be one of the most popular and most used methods of treatment both prophylactically and therapeutically.

Conflict of Interest

The authors declare that they have no conflict of interest.

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