VISUALIZATION OF THE STUDY FOR SPACE-TIME CONFIGURATION OF THE ELECTROMAGNETIC FIELD EMITTED BY EQUIPMENT FOR MICROWAVE THERAPY

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Abstract

The aim of this paper is to show the real dimensions of space - time configuration of the electromagnetic field in a near field area brought by symmetric and asymmetric dipole antenna used in microwave therapy. The bandwidth of these devices is in the range of 2 GHz to 3 GHz, thus resulting in a more effective treatment. These frequencies and wavelengths are the most efficient and enables much more deeply and better adjustability of the action intensity of warming. It's difficult to be provided one exact mathematical description of electromagnetic field in this area taking in account deformation of this field because of live tissues additionally. Because of that one experimental investigation of electromagnetic field in the patient's area would be useful in this case.

1. INTRODUCTION

The experimental measurements of the electromagnetic field in actual clinical environment were carried out for the most commonly used therapy modes, i.e. uninterrupted radio emission and in the near field area of emission since this is the interesting are when speaking for medical physiotherapy systems. The energy in the near field area emitted by an antenna with maximum allowed size ans yet still small compared to the wavelength is mostly reactive. Thus the accumulated energy is transmitted periodically between the antenna and the the near field area. The reactive near-by field extends from the antenna to a distance "R" from the antenna, which in our case is equal to 30 cm.

2. THEORETICAL SOLUTION

When it comes to medicine, wavelengths of 12.2cm, 12.4cm and 12.6 cm are most commonly used, which are close to UHF. In fact, the equipment is mainly operating at power up to 200W and 2450 MHz wave frequency. For the conducted measurements exploring the space-time configuration of patient area is used transmission frequency close to the most commonly used frequency - 2.45 GHz with a wavelength of 12.44 cm.

When irradiating of homogeneous tissue, the heat is distributed in depth exponentially. It is clear that the distribution of endogenous heat inside the body is mainly determined by the space-time configuration of the electromagnetic field created by emitters in medical microwave therapy, therefore, the knowledge of this configuration is essential for achieving the desired healing effect.

The discovery of analytical and mathematical calculation models for exploring of space-time configuration of the electromagnetic field created by the emitter boils down to the calculating of the parameters of the radiation field from the emitting surface in general and in particular concerning the patient area. The generated heat is determined by the geometry of the emitters of the microwave device (its antennas), how they were positioned on the body, the frequency of the electromagnetic field, the electrical conductivity of the tissue and their dielectric properties.

Figure 1 and Figure 2 show the two experimental settings.

Fig. 1. Setting with asymemetric dipole antenna

Fig. 2. Setting with symemetric dipole antenna

Measurements of power density were carried out at various points along the legth of the patient's bed. The purpose of measurement is to determine the space configuration of the electromagnetic field in the near field area of the antenna system (surface of the patient), as well as to determineing the intensity maximums created by the antenna. In this case it could be usefull to deal with relative units of power. Of course, these values refer to the absolute values with a coefficinet. Two types of antennas are measured according to the treated area of patient's body at a distance of 30 cm from the patient bed. [1]

3. RESULTS AND ILLUSTRATION OF THE EXPERIMENTAL INVESTIGATION OF THE ELECTROMAGNETIC FIELD

The first one is an asymmetric vibrator which is typically used for already determined areas (eg elbow, wrist, knee, foot) or by paediatrics. The second antenna is symmetrical vibrator used for treating areas like a neck, shoulders back or pelvis. [2]

Due to high levels of both types of antennas attenuators were used to reduce the signal strength. For the measurements of the first antenna were used 70 dB and 80 dB power reduction, while the second the reduction was only 40 dB. A special device for measuring the power of the electromagnetic field was used in the experimet - HF Analyser 38B by GigaHerzt Solution company and the period for measuring the values was 3 seconds. The measurement device and the antennas with which the data were obtained are shown in Figure 3 and Figure 4.

As you know, essential in measuring here is the polarization of the antenna - whether it is vertical or horizontal. With the antenna attached the meter measures the vertically polarized component, if the display is positioned horizontally. By rotating the meter around its longitudinal axis you will be able to pick up any polarization plane. Due to the physics of wave generation it is not possible to reliably measure the customary "power density" (W/m^2) in the close vicinity of the source of radiation. For the instruments described here, the distance should be in excess of 30 cm. For the measurements were taken the peak values of the power density through the special option of the HF Analyzer.

Fig. 3. The metering device and antenna

Fig. 4. The measuring antenna

In Table 1, Table 2 and Table 3 are shown in relative units of the measured power values of the field, as well as the length of the patient bed, and perpendicular to it at the asymmetric dipole antena. Figure 5, Figure 6 and Figure 7 show the results graphically, at 70 dB and 80 dB gain.

Table 1. Relative values of the measured power P in perpendicular placement of the antenna in the patient area, 70 dB gain

Lenght, cm	1	2	3	4	5	6	7	8	9
Power P, relative units, 70 dB gain	12.7	15.48	15.7	19.3	16.2	16	8.5	11.87	12

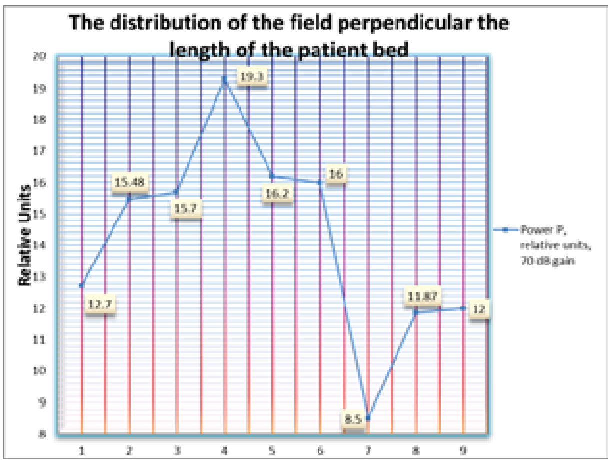

Fig. 5. Graph of the measured values of the power P
in perpendicular placement of the antenna in the patient area,
70 dB gain

Table 2. Relative values of the measured power P
in perpendicular placement of the antenna in the patient area,
80 dB gain

Lenght, cm	1	3	5	7	9	11	13	15
Power P, relative units, 80 dB gain	1.44	1.21	0.93	1.51	1.7	1.61	1.71	1.1

Lenght, cm	17	19	21	25	30	35	40
Power P, relative units, 80 dB gain	0.81	1.07	0.83	0.65	1	0.35	0.58

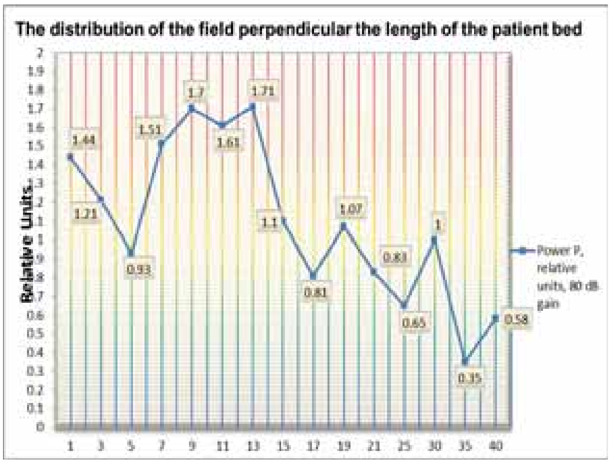

Fig. 6. Graph of the measured values of the power P
in perpendicular placement of the antenna in the patient area,
70 dB gain

Table 3. Relative values of the measured power P in parallel placement of the antenna in the patient area, 80 dB gain

Lenght, cm	0	5	10	15	20	25	30	35
Power P, relative units, 80 dB gain	1.63	1.1	0.7	1.01	0.95	0.7	0.68	0.65

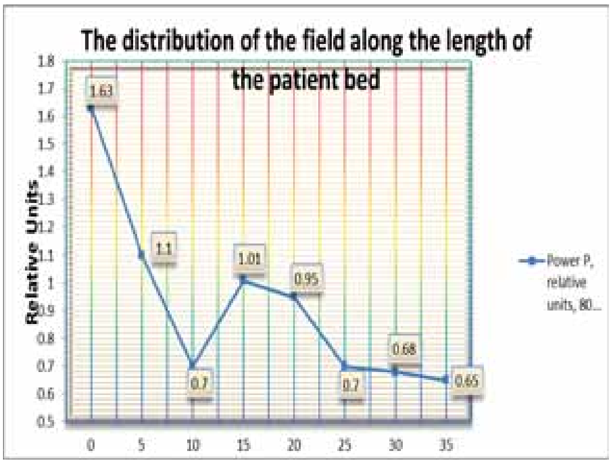

Fig. 7. Graph of the measured values of the power P
in parallel placement of the antenna in the patient area,
70 dB gain

Table 4 and Table 5 show the relative units of the measured power values of the field, as well as the length of the patient bed, and perpendicular to it at a symmetric dipole antena. Figure 8 and Figure 9 depicts the results graphically at 40 dB gain.

Table 4. Relative values of the measured power P
in perpendicular placement of the antenna in the patient area,
40 dB gain

Lenght, cm	0	2,5	5	7,5	9	11,5	13	15	17,5	20	22,5
Power P, relative units, 40 dB gain	8.45	17.35	16.18	17.6	18.05	36.51	38.92	36.37	36.84	37.3	24.94

Lenght, cm	25	27,5	29	32,5	35	37,5	40	45	50	55	60	65
Power P, relative units, 40 dB gain	25.55	26.1	32.32	29.7	27.9	23.93	27.75	27.4	26	30.5	26	28.34

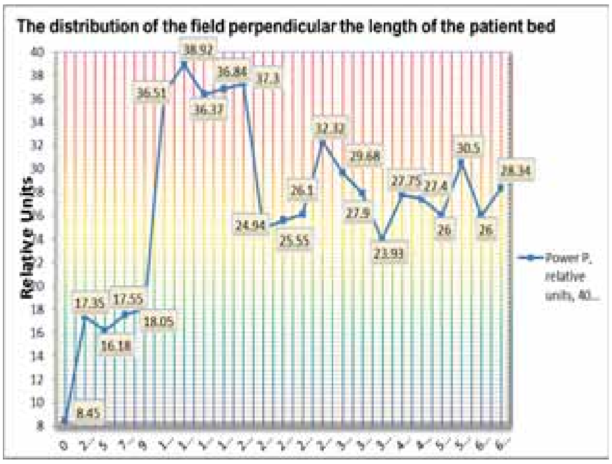

Fig. 8. Graph of the measured values of the power P
in perpendicular placement of the antenna in the patient area,
70 dB gain

Table 4. Relative values of the measured power P in parallel placement of the antenna in the patient area, 40 dB gain

Lenght, cm	0	5	10	15	20	25	30	35
Power P, relative units, 40 dB gain	28.1	27.4	28.6	23.7	31.65	29.06	26.5	23.4

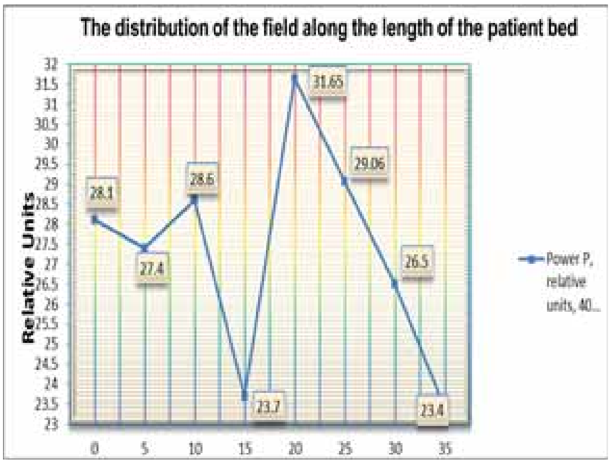

Fig. 9. Graph of the measured values of the power P in parallel placement of the antenna in the patient area, 70 dB gain

7. CONCLUSION

In conclusion we can say that these waves penetrate deep into the human body and have very good therapeutic effect, which leads to their frequent use. Therefore, it is necessary to study them and in particular the characteristics of the electromagnetic field at the near field area, together with the optimization of the space-time configuration of the electromagnetic field. This is crucial to achieve the desired therapeutic effect.

References

[1] D. Dimitrov, Medical systems influence of electromagnetic fields on human,education book, TU-Sofia,2007

[2] W. Y. Riadh, "Electromagnetic Fields and Radiation (Human Bioffects and Safety)",Marcel Dekker Inc. Canada,2001,ISBN 0-8247-0877-3