1800 MHz GSM RADIATION EFFECTS ON HUMAN BLOOD MONOCYTES MEMBRANE ANISOTROPY

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Abstract: The purpose of our experiments was to measure the effects of 1800 MHz microwave radiation on membrane anisotropy of a human blood monocitar cell population. Power level of the applied CW microwave radiation was low enough to consider it to be athermal. Experience demonstrates that the natural tendency to decrease of cell membrane anisotropy is favourised by microwave irradiation. This tendency maintains after the ceasing of microwave irradiation.

Introduction

There are in literature a lot of results concerning positive effects of low level electromagnetic waves in the GSM frequency bands. So, studies made in Poland [1] reported the decrease of apparition age of neoplazia in soldiers previously implied in radio transmissions. Malign neoplazia are present mainly in skin, brain, blood and lymphatic system. German researchers [2] found that use of mobile phones may be associated with an increased risk of uveal malign melanoma.

Studies on healthy volunteers shown that exposition at GSM radiation may result in modifications of brain activity. These changes were emphasized by specific tests showing direct cortex stimulation [3], increase of reaction speed [4], [5], decrease of necessary time to make simple aritmetical operations [6]. In some situations one may find out sensations as headaches, dizziness, fatigue, sensation of skin heating [7]. An increase of local temperature and modifications of some cerebral physiologic parameters were experimentally observed by [8].

The target of these experiments was to find the effects of 1800 MHz microwave radiation on human cells. This frequency was chosen because it is used for the extension of mobile telephony systems. The biologic parameter followed in experiments was the membrane anisotropy of human blood monocytes.

Experimental method

The principle of the method consists in labeling the cellular membrane with a specific fluorescent dye. The biological sample is then illuminated with vertically polarized light and the emitted intensities of vertically (I_{vv}) and horizontally (I_{vh}) polarized light are measured.

Both the absorption and the emission of polarized light by a molecule are due to electronic transitions. A photon can be absorbed by a molecule only if the molecular transition moment lies in the polarization plane of the exciting incident light. Reciprocal, when it comes back in the initial status, the excited molecule emits light polarized in the plane of molecular transition moment.

It follows that from a populations of molecules randomly oriented, illuminated with polarized light, only a sub-population will be excited (those with the molecular transition moment properly oriented).

An excited molecule will remain in this status only a small (some nanoseconds) time – naturally life time of excited status. After this time it will relax emitting polarized light in the manner described above.

If during naturally life time of excited status the molecule changes its position (due to the thermal agitation) the emitted light will be in other direction that the absorbed exciting light. It follows that, naturally, the emitted light from this molecular population will have a polarizing index smaller than the incident light. The depolarizing degree is a measure of the freedom of movement of the molecules in the fluid, therefore a measure of the fluidity.

Usually, the incident light is vertically polarized and the measurement of the polarization of the emitted light are made in vertical (I_{vv}) and in the horizontal plane (I_{vh}) where the indexes ***v*** and ***h*** refers to the vertical, respectively horizontal polarizing plane.

The polarizing index of the emitted light is a measure of anisotropy (r) defined as:

$$r = \frac{I_{vv} - GI_{vh}}{I_{vv} + 2GI_{vh}} \qquad (1)$$

where:

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$$G = \frac{I_{hv}}{I_{hh}} \cong 1 \qquad (2)$$

is a parameter which corrects for the polarization bias in the instrument.

By measuring the depolarizing of the light emitted by this fluorescent material it is possible to evaluate the membrane fluidity. A high value of anisotropy means the stiffening of the membrane and inverse, a low value corresponds to a more fluid membrane.

The purpose of our experiments was, using the above exposed method, to measure the membrane anisotropy of a monocitar human blood cell population irradiated with 1800 MHz microwave radiation and to compare it with the membrane anisotropy of non-irradiated cells.

Biological material (blood platelets) used in experiments was taken over from two healthy human donors and separated by centrifugation. The platelet suspension was put in a fluorometric cuvette with dimensions 1×1×5 cm^3. The experimental arrangement allows simultaneous application of the polarized light and of the microwave radiation.

Experiments and results

The microwave experimental setup, it is presented in Fig.1. It consists in a microwave generator followed by a variable attenuator and an isolator with the role to prevent the reflected waves to reach the emitting device. The microwave chain contains two 20 dB directional couplers mounted as in Fig.1 in order to measure the direct and reflected power traveling in setup. Via two identical detectors, two voltages proportional with the direct and reflected microwave powers are displayed on the voltmeters (1) and (2). Prior the beginning of the experiments a calibration step is performed.

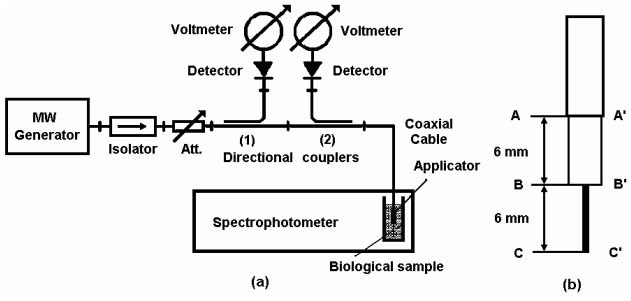

Figure 1: The microwave setup (a) and the applicator (b)

The radiating element is a λ/2 antenna (applicator) made using a semi-rigid cable. The external metallic sheet of the cable was removed on a length of 12 mm (section AA') and the cable's dielectric (teflon) was, also, removed on a length of 6 mm (section BB') exposing 6 mm of central conductor. The antenna is introduced in the container in such a manner that the exposed dielectric and the central conductor are totally submersed in the biological fluid (up to the section AA').

The microwave power level effectively injected in the biological sample is the difference resulting from direct power level minus reflected power level and minus the losses in cables and transitions.

From this power balance results a power of approx. 70 mW CW effectively injected in the biological sample. Because the content of the mini-container is approx. 4 g of biological sample it results a SAR = 18 mW/g.

Anisotropy was measured for 90 min at time intervals of 5 min. In the first 30 min the microwave radiation was not applied so that the anisotropy variation in this time interval vas considered as a measure for natural anisotropy decrease. In the next 30 min the biological samples were irradiated in the conditions presented above. Finally, for the last 30 min the microwave radiation was interrupted but the measurements continued at the same time interval of 5 min each in order to see the evolution of anisotropy following the irradiation.

The obtaining results are displayed in Tab.1 prior to, during and after the microwave irradiation. The normalization was made to the values of anisotropy at the beginning of each experimental step. One can see that the natural tendency of anisotropy is to decrease (in the first 30 min) and this tendency is maintained during the irradiating session and also after the interruption of microwave application.

Table 1: Decreasing of the anisotropy normalized values

Time (min)	Anisotropy		
	Pre-irradiation	Irradiation	Post-irradiation
0	1,000000	1,000000	1,000000
5	0,974368	0,884447	0,846760
10	0,953176	0,886860	0,848943
15	0,921274	0,878200	0,808124
20	0,910130	0,867567	0,841148
25	0,904110	0,835159	0,850051
30	0,900358	0,847229	0,811843

In order to have a better understanding of the microwave effects, a number of samples pairs were chosen following the criterion of closest values of the rate of the anisotropy decrease in the first 30 min (without microwave irradiation). One of the components of each pair was then irradiated with microwaves and the other was kept as reference. The rate of anisotropy decrease was measured during the time of microwave application as well as in the post-irradiation time.

The results for four pairs of biological probes are presented in Table 2. There is shown the difference between rates of the anisotropy decrease in the two biological samples in each pair. One may see an

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increasing rate of this parameter during the irradiation time, tendency maintained also in post-irradiation time.

The results showing the anisotropy increasing rate were drawn for the four biological sample pairs in Figs.1 … 4.

Table 2: Difference between rates of the anisotropy decrease for the biological samples in each pair.

Time (min)	Differences in rates of anisotropy decrease (absolute values)			
	First pair of biological samples	Second pair of biological samples	Third pair of biological samples	Fourth pair of biological samples
0	0,0000	0,0000	0,0000	0,0000
5	0,0100	0,0109	0,0181	0,0009
10	0,0099	0,0163	0,0052	0,0043
15	0,0116	0,0143	0,0147	0,0068
20	0,0103	0,0266	0,0067	0,0039
25	0,0123	0,0063	0,0043	0,0057
30	0,0110	0,0183	0,0185	0,0050
35	0,0134	0,0231	0,0338	0,0064
40	0,0144	0,0104	0,0289	0,0085
45	0,0260	0,0133	0,0292	0,0159
50	0,0277	0,0228	0,0325	0,0170
55	0,0253	0,0173	0,0310	0,0151
60	0,0357	0,0632	0,0342	0,0140
65	0,0403	0,0668	0,0266	0,0228
70	0,0344	0,0500	0,0369	0,0215
75	0,0329	0,0647	0,0345	0,0279
80	0,0414	0,0468	0,0441	0,0283
85	0,0327	0,0556	0,0484	0,0338
90	0,0391	0,0830	0,0605	0,0343

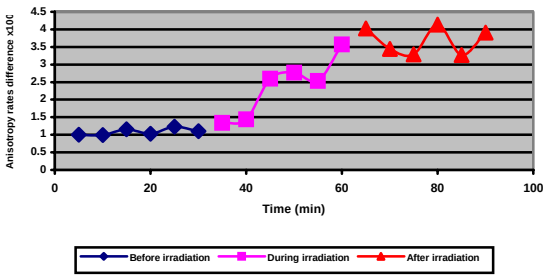

Figure 2: Anisotropy decreasing rate for the first biological sample pair (see Table II)

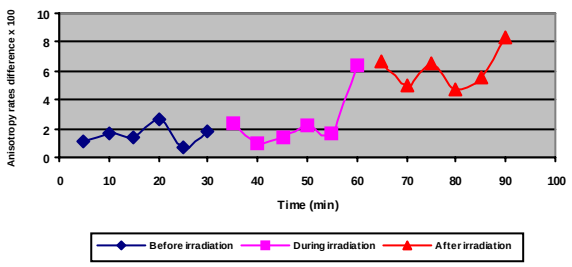

Figure 3: Anisotropy decreasing rate for the second biological sample pair (see Table II)

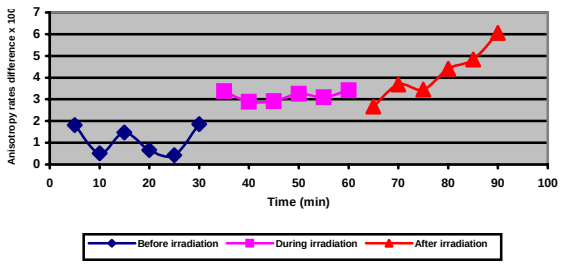

Figure 4: Anisotropy decreasing rate for the third biological sample pair (see Table II)

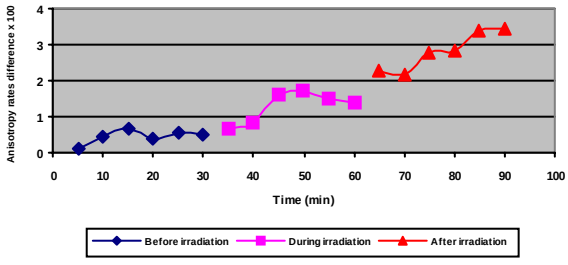

Figure 5: Anisotropy decreasing rate for the fourth biological sample pair (see Table II)

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Conclusions

In the above presented experiments power level of the applied microwave radiation was low enough to consider it to be athermal. From the numerical data and the drawings presented in this paper one may conclude the following:

a) During the experience (with or without microwave irradiation) the tendency of anisotropy of human blood monocytes is to decrease;
b) As one may see from Table 1, this decrease is greater when 1800 MHz microwave radiation is applied. This tendency is maintained after the ceasing of microwave irradiation.
c) For a better emphasizing of this result, samples pairs of blood samples were chosen following the criterion of closest values of the speed of the anisotropy decrease in the first 30 min. The speed of the anisotropy decrease was evaluated in the time and after the microwave irradiation. The result is presented in Table 2 and in Figures 1 to 4, showing the same effect on the speed of anisotropy decrease.

References

[1] SZMIGIELSKI S. (1996): "Cancer morbidity in subjects ocupationally exposed to high frequency (radio frequency and microwaves) electromagnetic radiation", Science of Tot.Environment, Vol.180, pp.9-17.
[2] STANG A., ANASTASSIOU G. et al. (2001): "The possible role of radio frequency radiation I the development of uveal melanoma", Epidemiology, Vol.12, pp.7-12.
[3] LEBEDEVA N.N., SULIMOV A.V., et al. (2000): "Cellular phone electromagnetic field effects on bioelectric activity of human brain", Crit.Rev.Biomed.Eng., Vol.28, nr.1-2, pp.323-337.
[4] PREECE A.W. et al.(1999): "Effect of a 915 MHz simulated mobile phone signal on cognitive function in man", Int.J.Radiat.Biol., Vol.75, nr.4, pp.447-456.
[5] U. K. STUDY (1999): "Mobile phones can make the brain work faster", Microwave News, Vol.19, nr.2, pp.1-11.
[6] KOIVISTO M., REVONSUO A., et al. (2000): "Effects of 902 MHz electromagnetic field emitted by cellular telephones on response times in humans", Neuroreport, 11(2), pp.413-415.
[7] KOIVISTO M., HAARALA C. et al. (2001): "GSM phone signal does not produce subjective symptoms", Bioelectromagnetics 22(3), pp. 212-215.
[8] KHUDNITSKII S.S. et al. (1999): "On the evaluation of the influence of cellular phones on their users", Med.Tr.Prom.Ekol., Vol.9, pp.20-24.

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