ISSN : 0974 - 7532 Volume 5 Issue 3

Trade Science Inc.

Research & Reviews in BioSciences

Regular Paper

RRBS, 5(3), 2011 [113-117]

Effect of mobile phone radiation on biophysical blood properties in rats

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Received: 29th June, 2011 ; Accepted: 29th July, 2011

ABSTRACT

Effects of electromagnetic field radiation generated by mobile phone on blood viscosity, plasma viscosity, hemolysis, Osmotic fragility, and blood components of rats have been investigated. Our results show that, there are significant effects on blood components and its viscosity which affects on blood circulation due many body problems. Red blood cells, White blood cells and Platelets are broken due to exposure to mobile phone. Also blood viscosity and plasma viscosity values are increased due to exposure to mobile phone. Osmotic fragility value is decreased due to exposure to mobile phone.

KEYWORDS

Mobile phone;
Blood structure;
Viscosity;
Osmotic fragility.

INTRODUCTION

Mobile phones transmit and receive Radio Frequency (RF) signals in order to communicate. The RF signals from mobile phones fall within the microwave part of the electromagnetic spectrum. Blood is a complex fluid whose flow properties are significantly affected by the arrangement, orientation and deformability of red blood cells. Blood viscosity is a measure of the resistance of blood to flow, which is being deformed by either shear stress or extensional stress. Blood is a liquid that consists of plasma and particles, such as the red blood cells. The viscosity of blood thus depends on the viscosity of the plasma, in combination with the hematocrit. The rheologic properties of blood depend on hematocrit and plasma constituents[1]. Blood is a shear thinning non-Newtonian fluid, meaning its viscosity decreases as the shear rate increases[2]. An increase in temperature results in a decrease in viscosity. The viscosity of blood thus depends on the viscosity of the plasma, in combination with the hematocrit. The viscosity of normal blood is about three times as great as the viscosity of water. When the hematocrit rises to 60 or 70, which it often does in polycythemia[3], the blood viscosity can become as great as 10 times that of water, and its flow through blood vessels is greatly retarded because of increased resistance to flow[4]. This will lead to decreased oxygen delivery[5]. The aim of this work was to study the effect of electromagnetic field radiation generated by mobile phone on blood viscosity, plasma viscosity, hemolysis, Osmotic fragility, and blood components of rats.

ANIMALS AND METHODOLOGY

Experiments were performed on adult Wistar Albino rats bred at the animal house of Biophysics Department, Faculty of Science, Mansoura University, Egypt, under conventional laboratory conditions. Wistar rats, 3 months old, were divided into three groups: I-control animals (10 animals) without near source of EMR, II- rats constantly exposed to EMR (20 animals) for 3 months and III-rats exposed to EMR (20 animals) for 6 months. Rats were exposed to 900 MHz continuous RF/MW fields for 1 hour daily, 7 days a week. All animals in control and experimental group were housed collectively in polycarbonate cages 30x40x40 cm (WxLxH) and given *ad libitum* access to standard laboratory food and water. The housing room was maintained at 24 °C with 42±5% relative humidity and had a 12/12 h light–dark cycle (light on 06:00–18:00 h). Experimental group was continually exposed to EMR from mobile phone. The microwave radiation was produced by a mobile test phone (model NOKIA 3110; Nokia Mobile Phones Ltd.). A 900 MHz electromagnetic near-field signal for GSM (Global System for Mobile communication at 900 MHz, continuous wave, analog phone) system was used. The mobile telephone was situated in the center of the cage, while the distance of EMR generator from the floor was 3 cm and maximal distance from the floor corners was 28.2 cm.

Rats were anesthetized with ketamine HCl (50 mg/kg), administered intraperitoneally (i.p.), before sacrificing, the blood from aorta was collected in plastic heparinised tubes for hematological and biophysical analyses. Determination of hematological parameters, (RBCs, WBCs, Platelets counts and hemoglobin concentration), by an automated hematologic analyzer using whole blood sample. The biophysical analyses comprised determination of blood hemolysis and viscosity. The absorption spectrum of oxyhemoglobin was recorded in the wavelength range from 200 to 700 nm by means of UV–visible spectrophotometer (2100 UV/ visible type SPECTRO SC, made in U.S.A). Data were analyzed using a commercially available statistics software package (SPSS® for Windows, v. 9.0, Chicago, USA). Results were presented as means ±SD. Statistical significance was determined at level of p<0.05 using the Student's t-test.

RESULTS AND DISCUSSION

From a biological point of view, blood can be considered as a tissue comprising various types of cells (RBCs, WBCs and platelets) and a liquid intercellular material (plasma). TABLE (1) and Figure (1) show that, there is a significant effect in blood rat structure due to exposed to mobile phone (radiofrequency microwave (RF/MW)) electromagnetic radiation. Values of RBCs, WBCs and platelets are decreased with increasing time exposure. That is mean these components of blood are broken due to irradiated by mobile phone electromagnetic radiation. Also after exposed rats to mobile phone radiation, there is a significant effect in Hemoglobin molecule structure due to damage/or broken of it as seen in TABLE (1).

TABLE 1 : RBCs, WBCs, Platelets and Haemoglobin before and after exposure to mobile phone electromagnetic radiation

Parameters	RBCs (10^6/µl)	WBCs (10^3/µl)	Haemo globin (g/dl)	Platelets (10^5/µl)
Control group	7.71±2.11	10.34±2.22	16±3	12.91±2.91
3 month group	5.34±1.12*	6.76±1.05*	13±2*	9.91±1.23*
6 month group	4.09±1.21*	2.34±0.99*	10±2*	7.19±1.09*

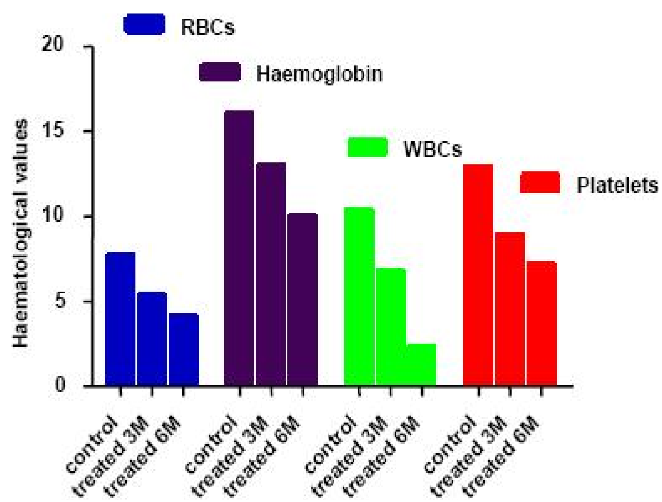

Figure 1 : Haematological parameters in different animals groups after 3 months and 6 months treatments

Because blood is a non-Newtonian suspension, its fluidity cannot be described by a single value of viscosity. Rotational viscometers allow the measurement of viscosity over a range of shear stresses (or shear rates), yielding a flow or viscosity curve for a blood sample. As shown in Figure (2), normal rat blood

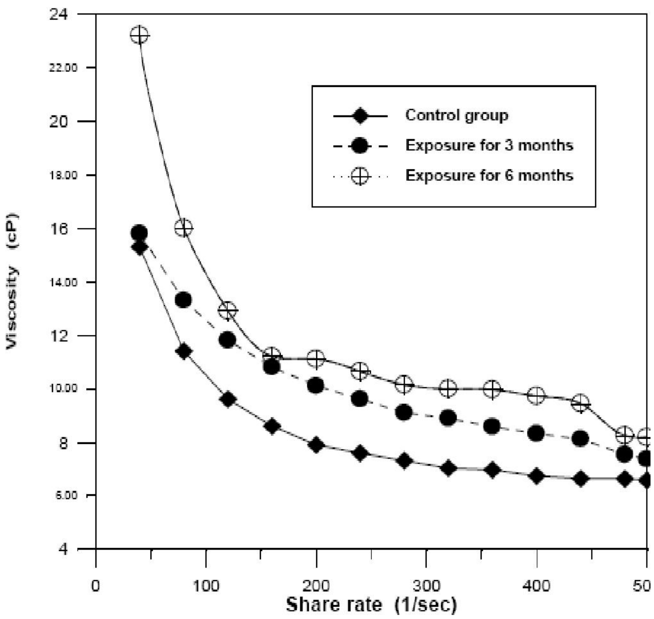

Figure 2 : Viscosity of blood versus share rate before and after exposure to mobile phone electromagnetic radiation

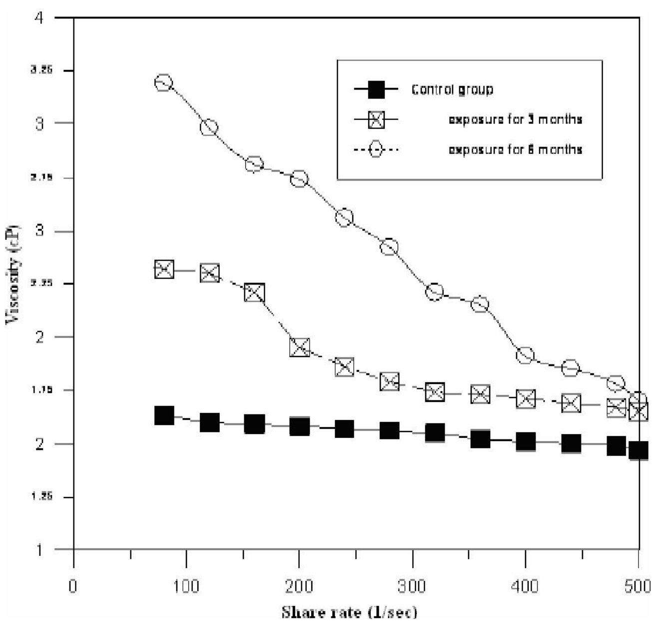

Figure 3 : Viscosity of plasma versus share rate before and after exposure to mobile phone electromagnetic radiation

exhibits shear-thinning behavior. At low shear rates or shear stresses the apparent viscosity is high, whereas the apparent viscosity decreases with increasing shear and approaches a minimum value under high shear forces. Also the viscosity becomes increasingly sensitive to shear rates below 100 sec^{-1}. The differences in viscosity at the lower and upper end of the shear rate range demonstrate the effects of RBC aggregation and deformability, respectively.

Plasma is the suspending phase for the cellular elements in blood, and thus a change in its viscosity directly affects blood viscosity regardless of the hematocrit and the properties of the cellular elements. Plasma is a Newtonian fluid (viscosity independent of shear rate). Figure (3) shows plasma viscosity before and after exposure to mobile phone

electromagnetic radiation. It is obvious that, plasma viscosity of rat before exposure to mobile phone electromagnetic radiation is a Newtonian fluid. Also it is increased after exposure (3 month and 6 month) to mobile phone electromagnetic radiation. That is may be because the rat has a disease due to exposure to mobile phone electromagnetic radiation which agreed with pervious results[6, 7].

Hemoglobin molecule is very sensitive to any change in its environment, where it responds and changes its conformation to carry oxygen and release carbon dioxide or vice versa. Exposure to mobile phone electromagnetic radiation was known to induce changes in the biological molecules. The absorption spectra of hemoglobin molecule can give some information about its conformational changes. Figure (4) shows the UV visible spectra of hemoglobin before and after exposure to mobile phone electromagnetic radiation. Mobile phone electromagnetic radiation may cause a conformational change on hemoglobin structure. This can appear from the decrease in the maximum absorption coefficient for the peaks recorded at 280 (aromatic side chains) and 340 nm. Strong absorptions (Soret band/ Soret peak/Intense peak) occur at 420 nm which agreed with[8, 9]. The Soret band is characteristic of hematoporphyrin proteins[10, 11].

The increase in the A420/A280 ratio reveals slight displacement of the porphyrin ring out from its globin pocket and that is agree with result[12]. Also the peak recorded at 340 nm has special importance. It is the transition of the non covalent bond between the proximal histidine and the iron atom[11]. The displacement of the porphyrin ring out of its pocket may result in increase in the length of this bond and its weakness, which affect the iron atom coordination inside the porphyrin ring. This suggestion can be supported by the observed decrease in the ratio of A420/A580. As the exposure time increased the damaging effect, extend to the molecular structure of the hemoglobin, significant effect, as seen in TABLE (2) which resulted in decrease in the total of hemoglobin.

TABLE 2 : The ratio of Soret band to the aromatic side chains and to the Qo band before and after exposure to mobile phone electromagnetic radiation

Samples	A420/280	A420/580
Control group	1.66±0.072	3.73±0.168
3 month	1.97±0.091	3.53±0.154
6 month	1.85±0.073	3.38±0.159

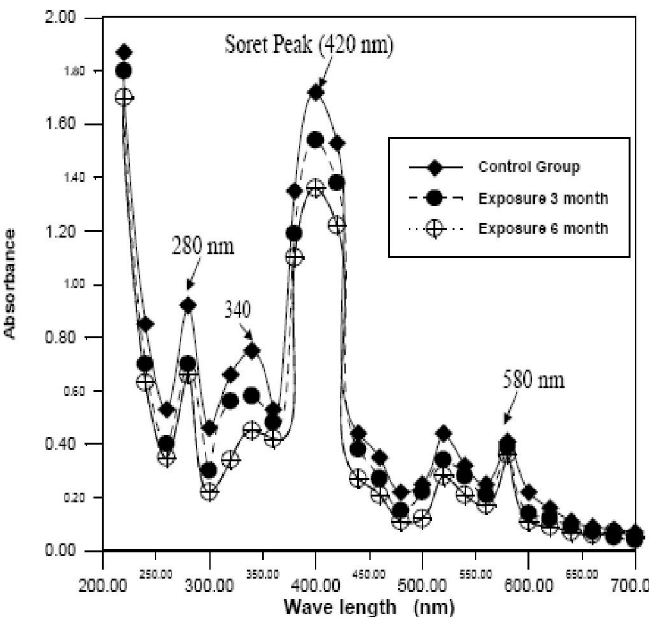

Figure 4 : The absorption spectra of hemoglobin molecules before and after exposure to mobile phone electromagnetic radiation

Osmotic fragility is a test to detect whether red blood cells are more likely to break down. In hematological studies, the osmotic fragility test provides an indication of

the ratio of surface area/volume of the erythrocyte. In the osmotic fragility test, whole blood was added to varying concentration of buffered sodium chloride solution and allowed to incubate at room temperature (25±1 ºc). The amount of hemolysis is nm on the spectrophotometer (UV/ visible type SPECTRO SC, made in U.S.A). Carefully transfer the supernatants to cuvettes and read on a spectrophotometer at a wavelength of 550 nm. Set the optical density at 0, using the supernatant in test tube No 1, which represents the blank, or 0 % hemolysis. Test tube No.14 represents 100 % hemolysis. The percent hemolysis was calculated for each supernatant as follow:

Percent Hemolysis =O.D of supernatant ÷O.D of supernatant No.14x 100

Where O.D= Optical Density

The percent hemolysis (H %) was then plotted as a function of the percentage of sodium chloride concentration (NaCl %) as seen in Figure (5). The percent hemolysis (H %) is decreased with exposure to mobile phone electromagnetic radiation.

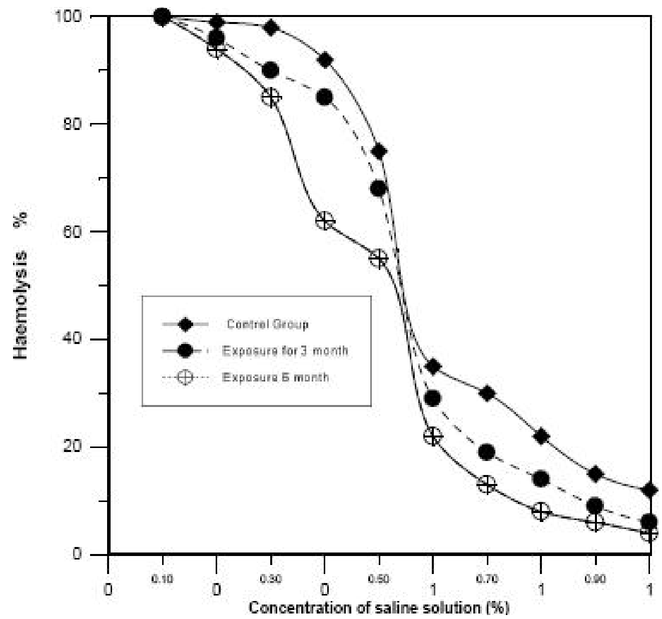

Figure 5 : percent hemolysis (H %) versus the percentage of sodium chloride concentration (NaCl %) before and after exposure to mobile phone electromagnetic radiation

CONCLUSION

Blood components of rats have a significant affects after exposure to mobile phone electromagnetic radiation such as decreasing values of RBCs, WBCs, Platelets and Haemoglobin molecules

Blood viscosity and plasma viscosity values are decreased after exposure to mobile phone electromagnetic radiation

Hemoglobin structure is effected due to exposure to mobile phone electromagnetic radiation.

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