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EFFECT OF ULTRASOUND ON ELECTRICAL CONDUCTIVITY OF HUMAN BLOOD OF DIFFERENT BLOOD GROUPS

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Abstract: The paper reports the data on electrical conductivity of normal and ultrasonic irradiated human blood of different groups. Blood samples were collected from healthy donors and stored in the anticoagulant EDTA. Using ultrasonic interferometer at the frequency of 3 MHz, blood samples were irradiated. The electrical conductivity of normal and irradiated blood samples were measured at an interval of 15 minutes exposure upto two hours. In the present study, the alterations in RBC physiology at the membrane level due to ultrasonic effect on electrical conductivity have been investigated.
Keywords: Human erythrocytes; Blood group.

1. Introduction

The interaction of acoustic waves with living systems guide to a special branch of physics called ultrasonic biophysics. The field finds its expansion with the growing medical interest in the clinical application of ultrasound. Several investigators studied the impedance properties of blood and gain important insights. These studies reveal that erythrocytes appear at low frequencies as non conducting particles in a conducting medium. The physiological effects of electric currents excited great popular and scientific interest in medical field as Electrotherapy.

Watchier [1] was probably the first to measure the absorption of ultrasound in water, blood, milk and other biological fluids at 1 to 10 GHz using the phenomenon of damped oscillations. Rajewsky and Schwan [2] were the first to report complex permittivity data on blood at 1 GHz and Cook [3] extended to still higher frequencies. Schawn and Pauly [4] studied dielectric properties and ion mobility in erythrocytes. Pfutzner [5] reported low frequency impedances of blood using raster electrode technique. Schawn [6] carried out the work on electrical properties of biological cells and tissues in the extremely low frequency region. Also he pointed out the most probable sites for EM field interaction. Gopala Krishna et al [7] reported the systematic dielectrophoretic study of human erythrocytes of A, B, AB

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and O blood groups in the frequency range of 0.1 MHz to 10 MHz using spherical field geometry. The strong dependence of Maxwell-Wagner polarisation response exhibited by erythrocytes of these blood groups was used as a parameter for their characterisation. Gopala Krishna et al studies dielectric properties of erythrocytes belonging to human [8, 9] and animals of different locomotion [10-12] through dielectrophoresis.

A sereach of literature reveals that extensive work has been done on dielectric properties of macromolecules, cell suspensions, soft tissues, but the information on the ultrasonic effects on electrical properties of human blood is scanty. It is in this context an attempt has been made to study the effect of ultrasound on conductivity of human blood of groups A, B, AB and O.

2. Materials & Methods

Blood samples of groups A, B, AB and O were collected from healthy donors and were irradiated with ultrasonic progressive waves at the frequency of 3MHz using ultrasonic interferometer (Mittal Enterprises). Electrical conductivity of normal and irradiated blood samples, exposed upto 2 hours at an interval of 15 min, was measured employing digital conductivity meter (Digisun electronics, Model 909).

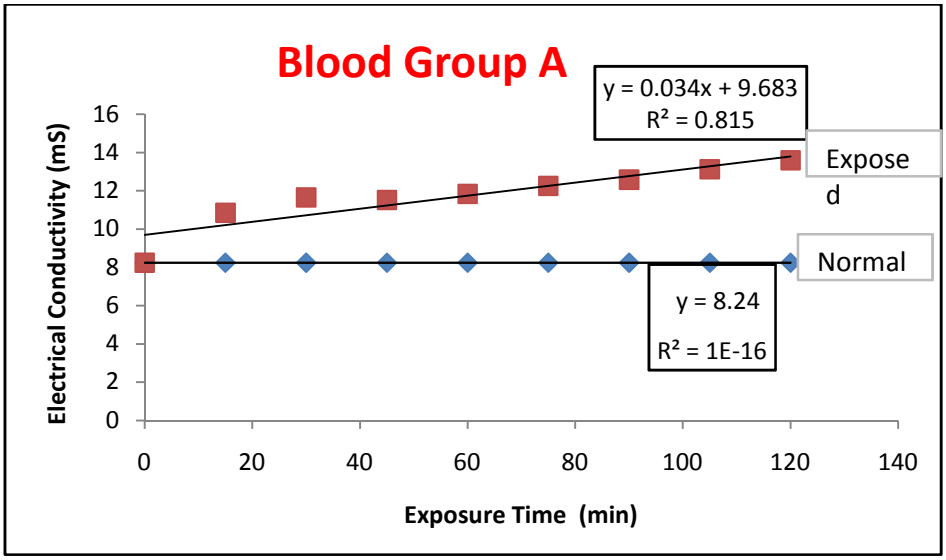
3. Results and Discussion

Table1 reveals data on variation of electrical conductivity of blood of groups A, B, AB and O, exposed to ultrasonic progressive waves at a time interval of 15 min. and also of normal sample as control.

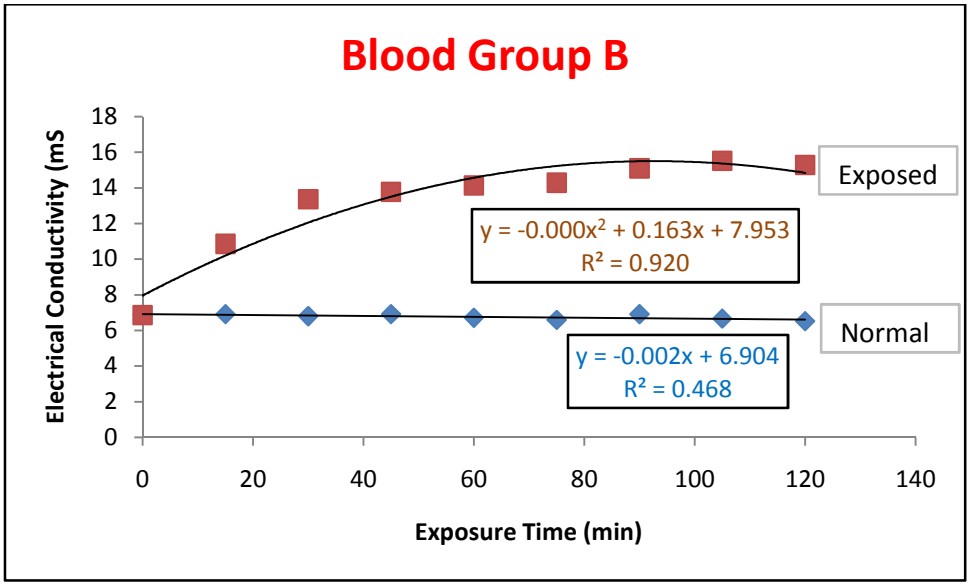
Table 1: Data on Electrical Conductivity of normal and ultrasonically irradiated human blood

Exposure Time (min)	Electrical Conductivity (mS)							
	Blood Group A		Blood Group B		Blood Group AB		Blood Group O	
	Normal	Irradiated	Normal	Irradiated	Normal	Irradiated	Normal	Irradiated
0	8.24	8.24	6.86	6.86	5.27	5.27	10.51	10.51
15	8.24	10.85	6.90	10.86	5.53	6.17	10.51	11.32
30	8.24	11.65	6.79	13.37	5.59	6.45	10.60	11.38
45	8.24	11.52	6.90	13.78	5.59	7.66	10.55	11.49
60	8.24	11.83	6.70	14.14	5.70	8.71	10.65	11.70
75	8.24	12.25	6.58	14.29	5.80	9.02	10.70	11.90
90	8.24	12.58	6.90	15.10	5.79	9.61	10.71	12.05
105	8.24	13.12	6.65	15.52	5.58	9.86	10.81	12.55
120	8.24	13.59	6.51	15.29	5.60	9.76	10.61	12.85

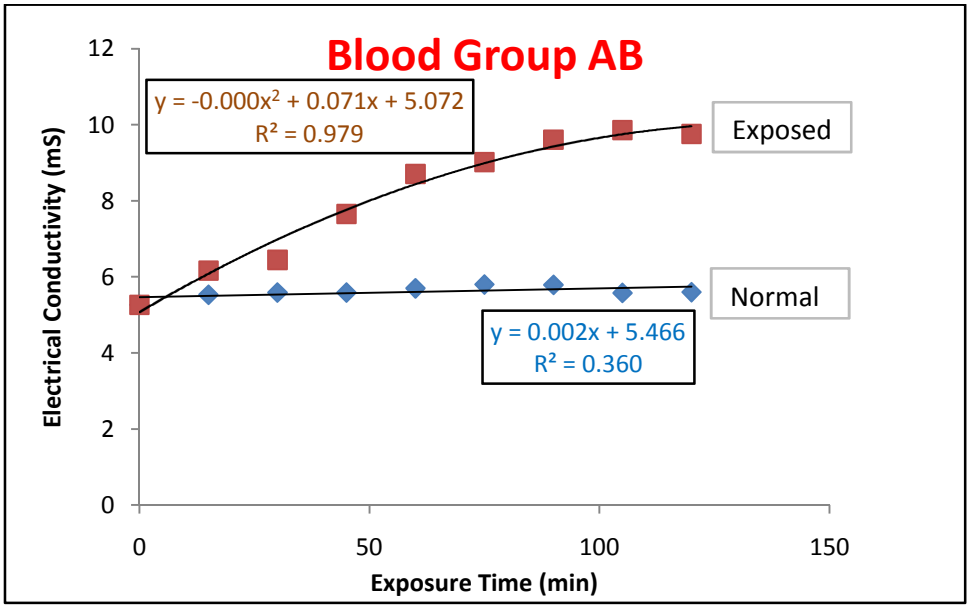
Fig 1(a-d) shows the plots between time of exposure of ultrasound of frequency 3 MHz on X-axis and electrical conductivity of blood on Y-axis for normal and irradiated blood of groups A, B, AB and O. It is evident from the figure that electrical conductivity of irradiated blood increases with the increase in time of exposure. But there is no change in electrical conductivity of normal (control) blood at room temperature, when observed for 2 hours with an interval of 15 min. It is interesting to note that electrical conductivity is maximum in irradiated blood of B group and minimum in blood of O group. However, increase in electrical conductivity due to ultrasonic exposure is more or less the same in the case of blood of A and AB groups as evident from Fig. 2.



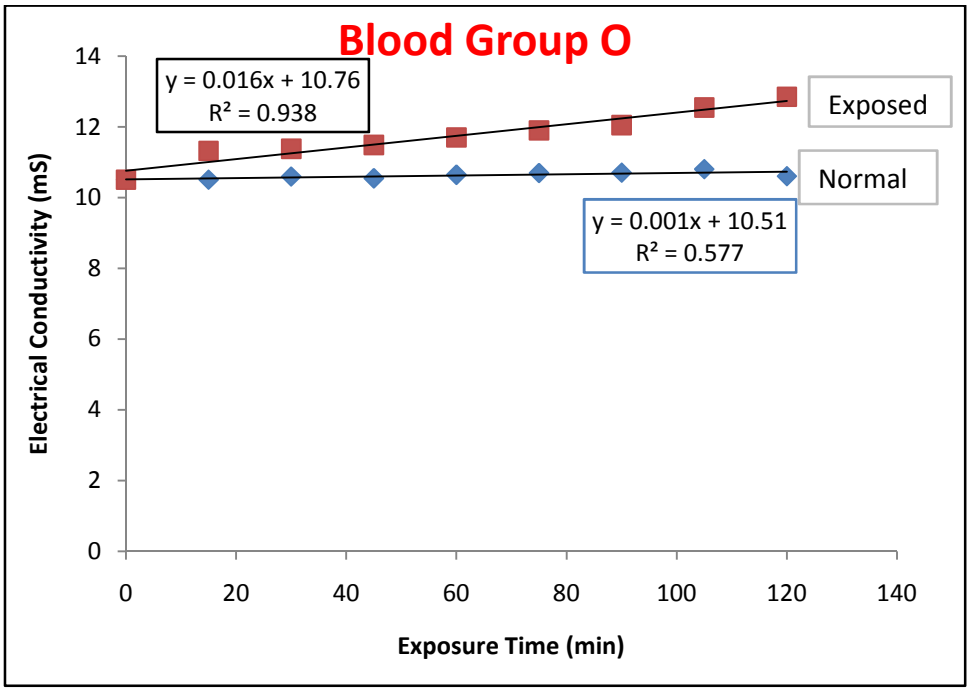
(a)



(b)

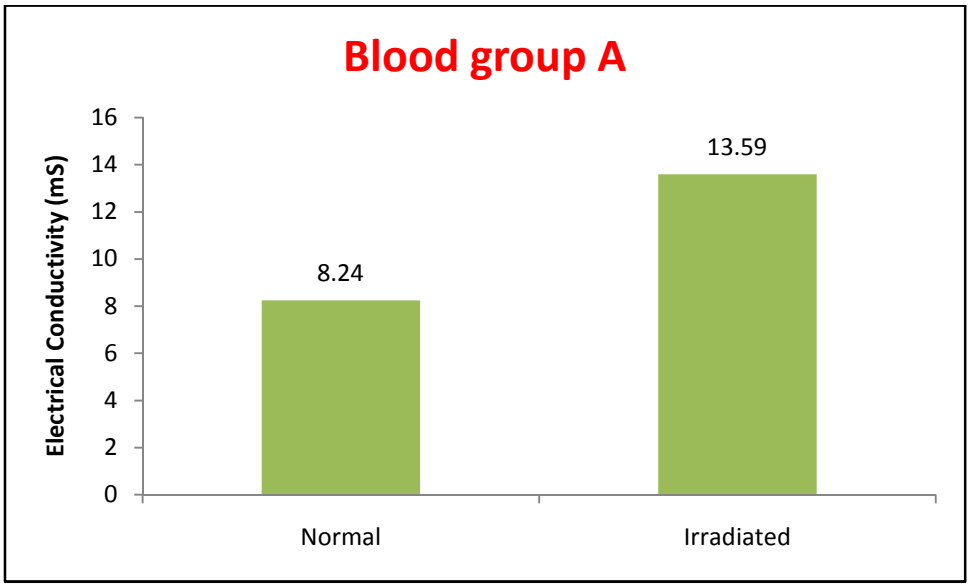


(c)

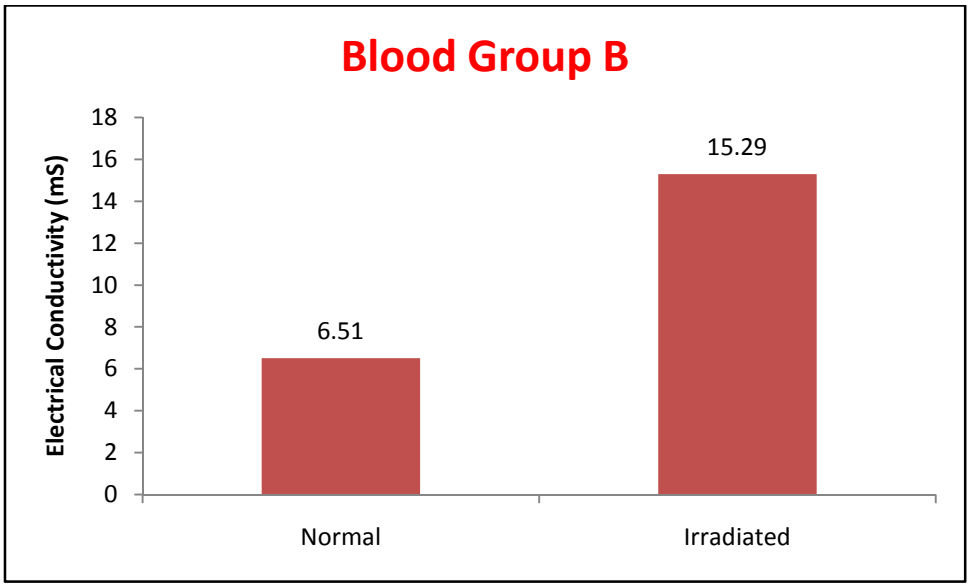


(d)

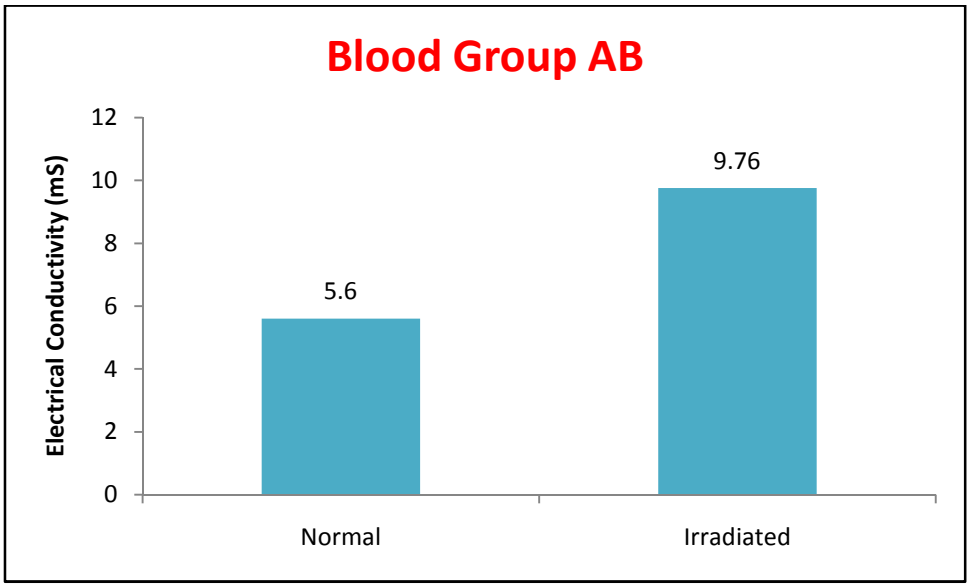
Fig. 1. Plots between Electrical conductivity of human blood and time of exposure of ultrasound of frequency 3 MHz.


Blood group A
Electrical Conductivity (mS)
16
14
12
10
8
6
4
2
0
8.24
13.59
Normal
Irradiated

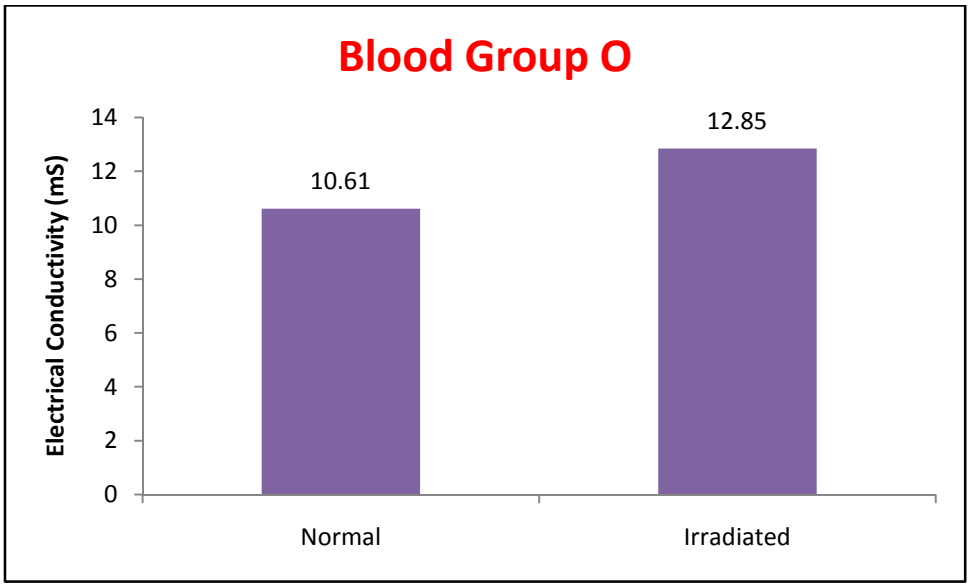
(a)


Blood Group B
Electrical Conductivity (mS)
18
16
14
12
10
8
6
4
2
0
6.51
15.29
Normal
Irradiated

(b)



(c)



(d)

Fig. 2(a – d). A comparison of electrical conductivity of normal blood and irradiated blood of groups A, B, AB & O for 2 hours.

The study suggests that the significant increase in electrical conductivity of ultrasonically irradiated blood of groups A, B, AB and O may perhaps be due to the coagulation of blood. Also, influence of ultrasound on human blood may be governed by the antigens present on erythrocyte membrane.

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