

# THE EFFECT OF ULTRAHIGH-FREQUENCY CURRENTS ON BLOOD SERUM PROTEIN FRACTIONS

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Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 52, No. 7,  
pp. 69-72, July, 1961

Original article submitted July 28, 1960\*

Data in the literature [1,2,5 and many other references] testify to the distinct, responsive reaction of the leucocytes and erythrocytes of an animal organism to the influence of an ultrahigh-frequency (UHF) electrical field. However, the effect of a UHF field on blood protein composition has been examined only incidentally and by few authors [3,6].

We felt it would be timely to carry out an experimental investigation to compare the effect of high-frequency currents, UHF, diathermy and d'Arsonval currents on the protein composition of rabbit blood.

## METHOD

The study was carried out on 56 healthy rabbits which weighed  $2.54 \pm 0.25$  kg each, and which were maintained under identical conditions, on a regular feeding regimen, during the experiment. The source of the UHF electrical field was a portable apparatus, the UVCh-1P or UVCh-4, the generators of which worked on a fixed wave of 6 m, with a therapeutic circuit capacity of 50 w. An air gap of 1-1.5 cm between the surface of the electrodes and the body of the animal was maintained during exposure. The electrodes were placed bitemporally in the region of the head, and bilaterally in the middle part of the trunk. As the source of the diathermy current we used the universal device UDL-200, which has a generator capacity of 200 watts. A current strength of 0.03-0.05 amp was applied. The electrodes were positioned bilaterally on the middle part of the trunk. For local d'Arsonvalization a portable apparatus with mushroom-shaped condenser electrodes, which was moved freely from one position to another along the flat surfaces of the trunk in the course of the experiment, was employed. During the experiment the rabbits were always secured in one position in a special wooden frame, in which they were also held during the blood extraction. The sample blood, withdrawn directly into a dry test tube, was taken from the local veins of the ear surface. Before beginning the experiment the total protein and protein fractions were measured five to seven times in each rabbit to establish individual normal values. Daily exposures were carried out for a period of 10 days; the exposures lasted 5 and 15 min. We assayed the blood protein composition during the exposures on the first, second, third, fifth, seventh and tenth days, before the exposure, and immediately after it, and also on the 15th and 20th days, when the exposures had been discontinued. The total protein was assayed refractometrically and the blood serum protein fractions were measured by paper electrophoresis. Conditions of separation: barbiturate buffer, pH 8.6, ionic strength 0.05-0.1, voltage 230-250 v, current strength 3.5-5 ma, time of separation 14-16 hours. We subjected the data obtained to statistical treatment of a corollary series. We referred to N. V. Luchnik's table [4] to test the reliability of the results and also the presence of reliable differences in the comparison of the individual indices.  $P=0.05$  was taken as the level of significance.

## RESULTS

In the first series of tests, which were performed on 40 rabbits, divided into four groups, we carried out two

\* Work materials were reported at scientific conferences at the Bashkirian Medical Institute on December 28, 1956 and April 16, 1959.

modifications of the exposure to the UHF currents; in the first, the period of exposure was 15 minutes; in the second, 5 minutes. The test results indicated that a 0.3 ml controlled blood sample at 1-2 day intervals over a period of 15-20 days revealed no marked effect on the content of total protein and protein fractions (see table). From the data of the table it is seen that during the influence of the UHF electrical field on the rabbit organism, a clearly indicated dysproteinemia sets in, which is expressed in a lowering of the content of the albumin and an elevation of the globulin fractions. A regular lowering of the blood serum albumin fraction, from the very first day after the action of the UHF field (for which a bilateral arrangement of the electrodes and an exposure of 15 minutes were employed), began in the animals; a maximum lowering was reached on the seventh day of the test. In comparison with the mean initial value, the relative content of albumins was lowered by 15.79% on these days. As a rule, the content of the  $\alpha_1$  globulin fraction increased by 33.76%, and the  $\gamma$  globulin fraction, by 41.12%. Although the content of the  $\beta$  globulin fraction was somewhat higher than the upper limit of the normal, this increase was not statistically reliable. The A/G ratio for these days reached a value of 1.13, in comparison with the original value of 1.69. The total protein content was increased slightly. The absolute content of the protein fractions changed in a manner analogous to the change in the relative indices of the proteinogram. Beginning on the tenth day, normalization started in the correlation of the blood serum protein fractions, with the exception of the  $\gamma$  globulin fraction, the content of which, in comparison with the original level, remained elevated by 37.65%. On the 20th day, when exposure had been discontinued, the correlation of the protein fractions returned to the original norm.

It was of interest to investigate how the duration of the UHF field exposure influenced the proteinogram. In order to do this, we studied the effect of the UHF fields in two groups of rabbits during 5 minutes exposure with bilateral and bitemporal positioning of the electrodes. As seen from the data of the table, the UHF field during the 5 minute action had a biphasic effect on the proteinogram of the rabbit blood serum. In the first phase the relative amounts of albumin were lowered, after the very first exposure to the UHF field, by 5.12%; the content of  $\gamma$  globulins

Changes in the Protein Fractions of Rabbit Blood Serum Due to the Action of UHF Fields

Duration of exposure (in min)	Time after exposure (in days)	Statistical index	Total protein (in g%)	Albumins	Globulins				A/Γ ratio	
					α <sub>1</sub>	α <sub>2</sub>	β	γ		
					in relative percentages					
Before experiment (average of 72 determinations)		M	6.56	62.73	7.82	6.86	9.87	12.72	1.69	
		±σ	±0.59	± 3.66	±1.01	±1.19	±1.26	±2.10	±0.12	
	15	1	M	6.79	59.93	7.93	6.63	10.61	14.90	1.49
			P	>0.05	= 0.01	>0.05	>0.05	>0.05	=0.001	>0.05
		3	M	7.06	57.76	8.86	6.42	10.66	16.30	1.36
			P	=0.001	= 0.01	>0.05	>0.05	>0.05	=0.001	>0.05
		7	M	7.04	52.83	10.46	7.29	11.47	17.95	1.13
			P	=0.001	=0.001	=0.01	>0.05	>0.05	=0.001	=0.01
		10	M	6.93	56.77	8.92	6.61	10.19	17.51	1.29
			P	=0.01	= 0.01	=0.01	>0.05	>0.05	=0.001	=0.01
	20	M	6.58	62.81	8.03	6.98	9.86	12.32	1.68	
		P	>0.05	> 0.05	>0.05	>0.05	>0.05	>0.05	>0.05	
Before experiment (average of 42 determinations)		M	6.51	57.35	8.82	7.56	10.54	15.73	1.33	
		±σ	±0.54	± 2.53	±1.17	±0.97	±1.60	±2.65	±0.12	
	5	1	M	6.46	54.53	9.03	7.86	10.95	17.63	1.19
			P	>0.05	= 0.01	>0.05	>0.05	>0.05	=0.01	>0.05
		3	M	7.10	57.26	10.28	7.57	9.37	15.52	1.33
			P	=0.01	> 0.05	=0.01	>0.05	>0.05	>0.05	>0.05
		10	M	6.78	50.12	10.20	9.32	12.54	17.82	1.00
			P	>0.05	=0.01	=0.01	=0.01	>0.05	=0.01	=0.01
		20	M	6.49	56.65	8.97	8.40	10.31	15.67	1.31
			P	>0.05	> 0.05	>0.05	>0.05	>0.05	>0.05	>0.05

Note. M is arithmetical mean;  $\sigma$ —standard deviation; P—probability, equal to 0.05.

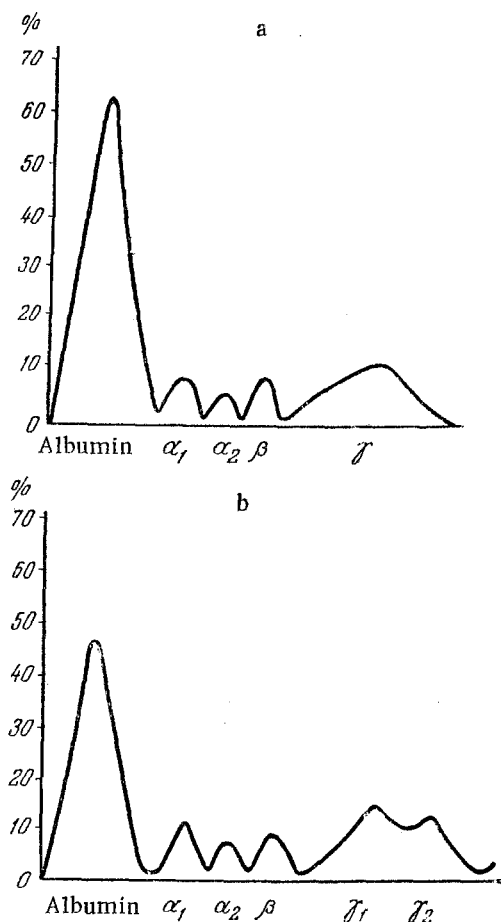


Fig. 1. Protein fractions of rabbit blood serum. a- Before the experiment, b- on the fifth day after daily exposure to the UHF electrical field.

In the case of the UHF field, dysproteinemia appeared immediately after the first exposure, and a return to the initial value in the correlation of the protein fractions did not begin until the 20th day; however, the change in the proteinogram of the rabbits after exposure to the diathermy current and the d'Arsonval current was very slight and of short duration. The blood protein picture during exposure to the diathermy currents did not change until the 10th day; this was expressed in an increased content of albumins, and a lowering of the  $\beta$  and  $\gamma$  globulins. Normalization of the proteinogram took place on the 15th day.

During exposure to the d'Arsonval currents, dysproteinemia appeared within three days after the beginning of the action and was manifested in a lowering of the albumin content and an elevation of the  $\gamma$  globulins. On the fifth day, the correlation of the protein fractions returned to its original norm. Furthermore, despite the duration of the influence of the d'Arsonval currents, this correlation was within the limits of the initial value.

Thus, the data obtained indicate that the UHF electrical field is a powerful stimulus for the animal organism and evokes a definite change in the protein composition of rabbit blood serum. Dysproteinemia arising under the influence of a UHF electrical field is more profound and more lasting than the dysproteinemia after exposure to diathermy and d'Arsonval currents. In considering the significance of globulin in the immunity processes, it can be assumed that the beneficial effect of the UHF electrical field in therapy consists in the elevation of the globulin fractions, especially the  $\gamma$  globulins, and that this strengthens the defensive forces of the organism.

#### SUMMARY

The author studied the effect of ultra-high frequency field, diathermy and d'Arsonval currents on the blood serum proteins of rabbits by the method of paper electrophoresis. Dysproteinemia occurring in the action of an ultra-high frequency field is characterized by a reduction of albumin and a rise of globulin content, especially  $\alpha_1$

rose by 12.07% in comparison with the initial value. On the third day, despite the extended action of the UHF field, the proteinogram returned to the initial norm and stayed at this level until the 10th day of the test. From the 10th day on, in the second phase, dysproteinemia once again set in, and was also expressed in a lowering of the albumins by 12.6% and an elevation of  $\alpha_1$  globulins by 15.64%,  $\alpha_2$  globulins by 23.28% and  $\gamma$  globulins by 13.28%. The A /  $\Gamma$  ratio was lowered to 1, in comparison with the original value of 1.33. On the 20th day the blood protein picture was once again the same as it was at the start.

Shifts in the fractional composition of the blood serum proteins brought about by the UHF electrical field, using a bitemporal placement of the electrodes, for both the 5-minute and 15-minute exposures, were analogous to the changes described above where a bilateral placement of the electrodes was used.

It should be noted that in all cases of exposure of the rabbits to the UHF field, we observed, after the very first session, the appearance on the electrophoretic curve, of one or, more often, two additional peaks, which were evidently the consequence of a separation in the  $\gamma$  globulin fraction (see figure). These complementary peaks in the electrophoregram were noted during the entire period of exposure, but no longer appeared on the electrophoregram obtained on the fifth day after cessation of the exposure.

A comparison of the rabbit proteinograms made at identical times after exposure to a UHF field, to a diathermy current, and to a d'Arsonval current revealed an especially great contrast in the biological effect of the UHF field.

and  $\gamma$  globulins. This dysproteinemia is more marked and prolonged than that provoked by diathermy and d'Arsonval currents. Considering the great role played by the globulins in the immunity processes a conclusion may be drawn that the favorable effect of ultra-high frequency field in the treatment of various diseases consists of the rise of globulin fractions, especially of  $\gamma$  globulins, intensifying the protective body functions.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.

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