EFFECT OF SHF IRRADIATION ON TISSUE ANTIGENIC PROPERTIES AND AUTOALLERGIC PROCESSES

G. I. Vinogradov and Yu. D. Dumanskii

UDC 612.017.1.014.426+615.846.015.46

Experiments on guinea pigs and albino rats by the anaphylaxis with desensitization method showed that SHF irradiation gives rise to changes in the antigenic composition of various tissues (brain, liver, kidney, spleen). These changes are characterized by the appearance of qualitatively new antigens and the disappearance of some of the antigenic properties of the normal tissue. Antibodies against irradiated and normal brain tissue were revealed by the complement fixation test in the cold.

KEY WORDS: SHF irradiation; antigenic properties of tissues; antibodies against irradiated brain tissue.

The antigenic properties of tissues after irradiation have been studied in two mutually complementary directions [11]: first, the detection of antibodies against autologous proteins in the blood of the irradiated animals [6, 7] and second, by direct experiments to study the antigenic properties of the tissues after irradiation in the anaphylaxis with desensitization test [3, 5]. These investigations have been carried out chiefly to study the immunological processes accompanying acute and chronic radiation sickness. In the accessible literature no data on changes in tissue antigens under the influence of SHF irradiation could be found.

The object of the present investigation was to study the antigenic structure of the tissues of experimental animals irradiated by an SHF electromagnetic field compared with the tissues of intact animals.

EXPERIMENTAL METHOD AND RESULTS

The method of active anaphylaxis with desensitization, associated with the name of L. A. Zil'ber, was used as a highly sensitive immunologic test. The choice was based on certain features of this test that have come to light as a result of practical experience [2, 9].

The organs and serum of noninbred albino rats of two groups, normal and irradiated with the SHF field, were used as preparations with which to sensitize guinea pigs. The animals were irradiated for 5 h daily for 14 days with the Luch-58 apparatus, using a power flux density of 50 $\mu W/cm^2$. The rats were then killed and 20% saline extracts prepared from their brain, liver, kidneys, and spleen. The protein content in the supernatant was determined by Lowry's method. Preparations of the organs of normal rats were obtained similarly.

All the guinea pigs were divided into groups depending on the antigen used for sensitization (six animals in each group). The tests were carried out so that if guinea pigs were sensitized with saline extracts of organs or with serum of irradiated rats they were desensitized with antigens prepared from normal animals, and the antigen used for sensitization was injected as the reacting dose. This principle was maintained also if the serum or organs from healthy rats were used as the sensitizing antigen. In all the

A. N. Marzeev Kiev Scientific-Research Institute of Social and Communal Hygiene. (Presented by Academician of the Academy of Medical Sciences of the USSR N. N. Sirotinin.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 78, No. 8, pp. 76-79, August, 1974. Original article submitted July 25, 1973.

TABLE 1. Anaphylaxis with Desensitization Test

Animal No.	Sensitization		Desensitization			Test of completeness of desensitization			Test of completeness of desensitization			Reacting injection		
	prepn.	dose (mg prot.)	prepn.	dose (mg prot.)	reaction	prepn.	dose (mg prot.)	reaction	prepn.	dose (mg prot.)	reaction	prepn.	dose (mg prot.)	reaction
21	Brain of irradiated animals	18	Brain of healthy animals	36	++	Brain of healthy animals	9	+++	Brain of healthy animals	18	—	Brain of irradiated animals	18	++
22	Same	18	Same	36	+	Same	9	++	Same	18	—	Same	18	+
23	"	18	"	36	++	"	9	++	"	18	—	"	18	+
24	"	18	"	36	++	"	9	++	"	18	—	"	18	++
25	"	18	"	36	++	"	9	+	"	18	—	"	18	++
26	"	18	"	36	++	"	9	—	"	18	—	"	18	++
31	Brain of healthy animals	18	Brain of irradiated animals	36	+	Brain of irradiated animals	9	+++	Brain of irradiated animals	18	—	Brain of healthy animals	18	+
32	Same	18	Same	36	++	Same	9	++	Same	18	—	Same	18	++
33	"	18	"	36	++	"	9	+	"	18	—	"	18	+
34	"	18	"	36	+	"	9	++	"	18	—	"	18	++
35	"	18	"	36	++	"	9	++	"	18	—	"	18	++
36	"	18	"	36	+	"	9	++	"	18	—	"	18	++

TABLE 2. Complement Fixation Test on Albino Rats after SHF Irradiation (M ± m)

Antigen from animal's brain tissue	Background		Immed. after irradia.		1 Week later		2 Weeks later		3 Weeks later		4 Weeks later	
	No. of positive reactions	log of antibody titer	No. of positive reactions	log of antibody titer	No. of positive reactions	log of antibody titer	No. of positive reactions	log of antibody titer	No. of positive reactions	log of antibody titer	No. of positive reactions	log of antibody titer
Irradiated rats	0	0	7	1,60±0,19	17	2,1±0,11	18	2,46±0,2	18	2,51±0,06	5	1,54±0,31
Normal rats	0	0	6	1,50±0,14	18	1,80±0,13	16	1,95±0,06	4	1,45±0,18	0	0

tests the homologous tissues from seven animals were used to sensitize the guinea pigs. Preparations consisting of a mixture of the homologous tissues from seven animals also were used for desensitization and for the reacting injection.

The guinea pigs were sensitized by three subcutaneous injections of the antigenic preparation (18 mg protein); the presence of sensitization was tested after 28 days by injection of the same preparations into the heart. Crossed desensitization was carried out by intraperitoneal, followed by intracardiac injection of the antigen. After verification of the completeness of desensitization, the reacting injection was given, with the antigen used for sensitization. The intervals between the repeated desensitizing injections were 2-2.5 h. According to Zil'ber, Petrov, and others [3-5, 10], the residual sensitization detectable by the reacting injection of antigen indicated the presence of a quality in the sensitizing antigen that was absent in the antigen used for desensitization.

The intensity of the anaphylactic reaction was recorded as follows: – no reaction; +repeated scratching of the nose and sneezing; ++scratching the nose, coughing, involuntary micturition and defecation; +++ seizures; ++++death of the animal.

Various organs and the serum of rats irradiated with the SHF field were investigated. The guinea pigs acting as the desensitization control always reacted with marked anaphylactic shock, terminating in most cases by death of the animals. Some guinea pigs were used as a control of the toxicity of the preparations injected. No definite reactions to a single injection of the antigen in the total dose were observed in these guinea pigs. No response reactions likewise were found in guinea pigs sensitized and desensitized by preparations of the brain of irradiated animals and receiving the same antigen at the reacting injection.

Since the results of the tests with different tissue antigens were similar in character, the difference between the antigenic properties of the brain tissue of the irradiated animals and those of the controls will be examined as an example (Table 1). It will be clear from the data given in Table 1 that sensitization created in guinea pigs by the injection of the brain tissue of the irradiated rats was not abolished by injection of the same preparation from healthy rats, i.e., that complete desensitization did not arise. Complete desensitization likewise was not observed if the guinea pigs were sensitized with saline extracts of the brain tissue of normal rats and desensitized by the homologous preparation from irradiated animals. This shows, first, that the changes in the antigenic composition of the tissue are characterized by the appearance of a new antigenic quality not normally present and, second, that some normal antigens dissappeared. The causes of these changes in the antigenic properties of the tissues under the influence of SHF irradiation are at present difficult to explain. Perhaps after SHF irradiation, as after exposure to ionizing radiation, the normal metabolism of proteins is disturbed, their physicochemical properties are modified, and the ratio between the content of different proteins in individual cell structures is changed. At the same time, various types of change in metabolism are known to give rise to changes in the antigenic properties of the tissues [4, 8]. A factor contributing to the change in the antigenic structure of the tissues of irradiated organisms may be that the autologous tissue proteins become heterologous and stimulate the development of an autoallergic process. The autoantigens formed in this way are considered to act on the reticulo-histiocytic system of the organism and to induce antibody formation [1, 11].

Since the discovery of autoantibodies against tissue elements is evidence of the participation of autoimmune mechanisms in the development of different pathological states, the dynamics of the formation of antibodies against brain tissue was studied in animals irradiated with the SHF field. For this purpose tests were carried out on 25 albino rats, 20 of which were irradiated with SHF energy for 14 days (power flux density 50 $\mu W/cm^2$). The sera of these and the five control animals were examined in the complement fixation test in the cold for their content of antibodies against the brain tissue of normal and irradiated rats. The reaction was carried out immediately after irradiation and thereafter weekly for 1 month. The results of this series of experiments are given in Table 2.

Analysis of these results showed that antibodies against both the normal and the antigenically changed brain tissue appeared in the experimental rats as a result of exposure to the SHF field. The highest titers of antibrain antibodies were observed 2 or even 3 weeks after irradiation (2.46 ± 0.2 and 2.51 ± 0.06, respectively). The antibody titer began to fall after 4 weeks, as also did the number of positive reactions. The formation of antibodies against antigens of the healthy tissue followed a similar course but their titers were rather lower. The results of the complement fixation test carried out on the sera before irradiation and in the control animals were negative.

The tissue antibodies thus discovered could react not only with injured cells against which they were formed, but also in some cases, evidently because of the presence of common determinant groups, they could react with injured tissues by changing their antigenic structure.

It can be concluded from the results of these experiments that exposure to SHF irradiation induces changes in the antigenic composition of the tissues, making them immunologically heterogeneic.

LITERATURE CITED

1. A. D. Ado, Allergy [in Russian], Moscow (1970).
2. B. D. Brondz, Byull. Éksperim. Biol. i Med., No. 8, 86 (1961).
3. L. A. Zil'ber, V. A. Artamonova, and G. M. Frank, Med. Radiol., No. 2, 17 (1956).
4. L. A. Zil'ber and V. D. Timakov, Zh. Mikrobiol., No. 1, 8 (1952).
5. L. I. Il'ina and R. V. Petrov, in: Collected Abstracts on Radiation Medicine for 1957 [in Russian], Moscow (1959), No. 1, p. 29.
6. P. N. Kiselev, P. A. Buzinin, and V. A. Semina, Vestn. Rentgenol., No. 3, 3 (1955).
7. P. N. Kiselev and V. A. Semina, Zh. Mikrobiol., No. 1, 44 (1959).
8. P. N. Kosyakov, Antigenic Substances of the Organism and Their Importance in Biology and Medicine [in Russian], Moscow (1954).
9. V. M. Parnes, The Immunology of Leukemia [in Russian], Moscow (1960).
10. R. V. Petrov, The Immunology of Acute Radiation Sickness [in Russian], Moscow (1960).
11. J. Lear, Acta Med. Scand., 132, Suppl. 306, 39 (1955).