

THE EFFECT OF A SINGLE LOCAL IRRADIATION ON THE PERIPHERAL VESSELS AND THEIR REACTION TO THE ADMINISTRATION OF ADRENALIN

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In investigating the biological action of ionizing radiation on the organism, a great deal of attention has been directed toward disturbances in the permeability and tonus of the vessels associated with exposure to both large and arbitrarily small doses of radiation.

Many works have indicated a marked elevation in the permeability of the vessel wall subsequent to total irradiation with a dose of 500-1000 r, i.e., in the period of development of radiation sickness [1, 3, 4, 6, 9, 11].

A number of investigators have studied the change in vascular tonus subsequent to exposure to roentgen rays [5, 7, 16]. A. A. Nikulin [13] established an increase in the tonus of the vessel wall in isolated frog organs, under the influence of small, medium, and large doses of radiation. S. B. Balmukhanov and K. I. Zholkiver [2] noted the appearance of vasomotor shifts even with a low intensity of radiation.

We studied the biological action of ionizing radiation on the reaction of the peripheral vessels, using a single, local irradiation. The functional state of the vessels was investigated in the rabbit ear, isolated at various intervals after irradiation, following the method of Kravkov-Pisemskii.

EXPERIMENTAL METHOD

In the experiment, we used adult rabbits, weighing from 2800 to 3600 grams; a total of 43 experiments were set up. The ear of the animal was irradiated on the RUM-3 apparatus; the head was shielded with a rubber guard, and the ear was fixed in place and subjected to local irradiation under the following physico-technical conditions: force of 160 kv, cutaneous focal distance 30 cm, current intensity 10 ma, filters of 0.5 mm copper + 1 mm aluminum, dose output of 28 r/min, tubulure 6 · 18 cm. In all cases, irradiation was applied once, with a dose of 100 r.

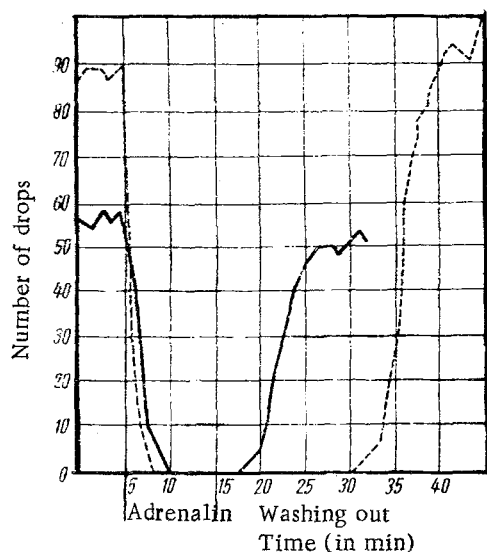
The experiments on the isolated ear were carried out according to the widely accepted method. The amount of fluid flowing out through the veins was determined by counting the number of drops per minute, no earlier than one hour after initiation of the investigation, when we established a constant flow of fluid, i.e., the complete disappearance of signs of spasm.

EXPERIMENTAL RESULTS

Reaction of the Vessels to Exposure to Roentgen Rays, at Various Intervals after the Irradiation

Time experiment was performed after irradiation	No. of experiments		Mean duration of spasm (in min)
	total	occurrence of vascular spasm	
After 1 day	5	1	15
After 2 days	6	3	21
After 3 days	5	3	28
After 4 days	5	4	26

Experiments were begun simultaneously on the ear vessels of control rabbits and a rabbit ear isolated 24 hours after irradiation. Starting from the very first experiments, we noted the following; in the 8 control experiments, we noted manifest initial spasm of the vessels; the mean duration of the spasm was 46 min, and the mean amount of fluid flowing out of the veins after termination of the spasm was found to be in the region of 56 drops per min. In the experiments with the vessels of the rabbit ear isolated 24 hours after irradiation, we did not observe spasm of the vessels; starting with the first minutes that the Ringer-Locke's solution was passed through the vessels, we established a definite number



The reaction of isolated vessels of a rabbit ear to the administration of Sol. Adrenalini hydrochlorici, 1 : 1,000,000, 24 hours after the irradiation (Expt. No. 33). Straight line) control broken line) irradiation.

Thus, the effect of roentgen rays on the vessel receptors of the rabbit ear is most clearly manifested 24 h after the irradiation, as shown by the disappearance of the initial spasm and the dilatation of the vessels; at later intervals after the exposure, the action of the radiation is weakened.

We performed further experiments on 14 rabbits, with the purpose of studying the reactions of the ear vessels to the administration of adrenalin, after preliminary irradiation. The rabbit ear was subjected to local irradiation under the same technical conditions as in the experiments performed earlier, using a dose of 100 R.

In the 4 control experiments, after stabilization of the flow of fluid, the administration of adrenalin in a dilution of 1 : 1,000,000 led to rapid constriction of the lumen of the vessels, up to complete spasm by the 4th-6th min. Upon washing out the adrenalin, the first drops of fluid also appeared at early intervals - by the 2nd-5th min; by the 17th min, on the average, the amount of outflowing fluid again attained its maximum, but in 3 experiments, after prolonged washing, the lumen of the vessels still remained smaller than the original.

The reaction of the vessels to the administration of adrenalin 1, 2, and 4 days after the irradiation, was studied in 10 rabbits. After one day, and on subsequent days after the exposure to radiation, the vessels of the ear reacted to the administration of adrenalin, as in the normal animal, by an energetic constriction, up to complete spasm by the 4th-6th min, but, in all cases, this constriction of the vascular lumen was more pronounced and more prolonged. In the experiment represented in the figure, as in the other experiments, profound spasm disappeared no earlier than 16-19 min after initiation of the "washing out" process. The lumen of the vessels returned to the initial size by the 27th min, on the average, and only in one experiment (on the 4th day after irradiation) out of the 10 that were performed after irradiation did the lumen of the vessels remain constricted for a long time and not attain the original size; in the remaining cases, the prolonged contraction of the vessels was relieved by their marked dilatation, and the number of outflowing drops exceeded the original indices.

The statistical significance of the difference in the nature of the vascular reactions to the administration of adrenalin, as compared with the normal, confirmed by statistical analysis of the obtained data, permits concluding that on the 1st-4th days after a single, local irradiation of the rabbit ear with a dose of 100 R, the vascular tonus is altered, the reaction to adrenalin is intensified, and its duration is increased.

of drops, which was retained right up to the end of the investigation. A total of 5 experiments were performed 24 h after the irradiation, and only in one did we note an initial, transient spasm of the vessels over a course of 15 min. The amount of fluid flowing out of the veins exceeded the figure for the controls, being equal to an average of 72 drops per min (statistical analysis of the results confirmed the validity of the difference). The obtained data made it possible to continue the experiments without applying pharmacological agents that influence the tonus of the vessels.

For this purpose, we carried out an additional 3 series of experiments, in which we determined the reaction of the vessels to exposure to the same dose of roentgen rays, but at various intervals - 2, 3, and 4 days, after the irradiation. In this case, from the moment that the perfusion was begun, the vessels responded with spasms that differed in degree and duration.

As can be seen from the table, there was characteristically a complete disappearance of vascular spasm on the 1st day after the irradiation: in the subsequent days, an initial spasm was noted in a large number of the experiments. The amount of fluid flowing out of the veins in the process of perfusion, on the 2nd-4th days after the irradiation, somewhat exceeded the mean indices obtained in the control experiments, but this difference was not substantial or statistically significant.

SUMMARY

The perfusion method was used to study the reaction of the vessels in the rabbit ear, isolated on the 1st-4th day after local irradiation with a dose of 100 R. The effect was most pronounced one day after the irradiation, and was manifested by the disappearance of the spasm and dilatation of the vessels. In response to adrenalin administration, the vessels of the irradiated rabbit ear showed a more profound and more prolonged constriction than that seen in the control, followed by subsequent dilatation.

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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.
