

THE STATE OF THE RECEPTOR APPARATUS IN THE WALLS OF CERTAIN MAJOR BLOOD VESSELS AFTER IRRADIATION BY X-RAYS

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In papers by Soviet scientists numerous findings have been reported, developing the teaching of I. P. Pavlov on the role of the nervous receptors in pathological conditions. Of great importance here are morphological investigations of the state of the receptor apparatus in various pathological processes. In this direction work has been successfully carried out for many years in the laboratory directed by B. A. Dolgo-Saburov. V. V. Kupriyanov [5], for instance, discovered well marked paranecrotic changes in the afferent apparatus during experimental oxygen lack. On the basis of his investigations this author came to the conclusion that the reaction in the afferent endings arises sooner than in the nerve cells themselves. Similar findings were obtained by B. A. Dolgo-Saburov [3] after abolition of efferent activity and by V. V. Astakhova [1] during experimental fever.

In 1954, a start was made on a morphological investigation of the receptors of certain major vessels after the action of x-rays. Many authors [2, 6, 7, 8] have demonstrated marked reflex disorders appearing after x-ray irradiation. These disorders form one of the main links in the pathogenetic chain of development of acute radiation sickness. In view of this it appeared important to ascertain the state of the structure of the interoceptors after the action of ionizing radiation.

EXPERIMENTAL METHOD

At the beginning of our investigation we studied the nervous apparatus in the wall of certain major blood vessels in animals exposed to the action of large doses of x-rays. The material used in the investigation comprised the carotid sinus zone, the venae cavae and the pulmonary and portal veins. These vessels were fixed in 12% neutral formalin solution for 12-14 days, stained by the Bielschowsky-Gros method and later counterstained with hematoxylin-eosin.

Material from 10 cats was studied. Before irradiation careful observations were carried out on the cats for a period of 15 days, including measurement of the temperature and body weight and full blood count; only healthy male animals were selected for the experiment. After this procedure the animals were irradiated with a dose of 600 r.

On the 3rd day after irradiation the general condition of the cats was good, but they showed considerable changes in the composition of the peripheral blood in the form of leucopenia with a relative and absolute lymphocytopenia, characteristic of the latent period of acute radiation sickness. The animals were killed at this period and material taken for histological examination.

EXPERIMENTAL RESULTS

As a result of the study of the preparations it was established that on the 3rd day after irradiation various changes could be observed in the nervous apparatus in the walls of certain major blood vessels, ranging from increased argentophilia to total destruction of the terminal apparatus.

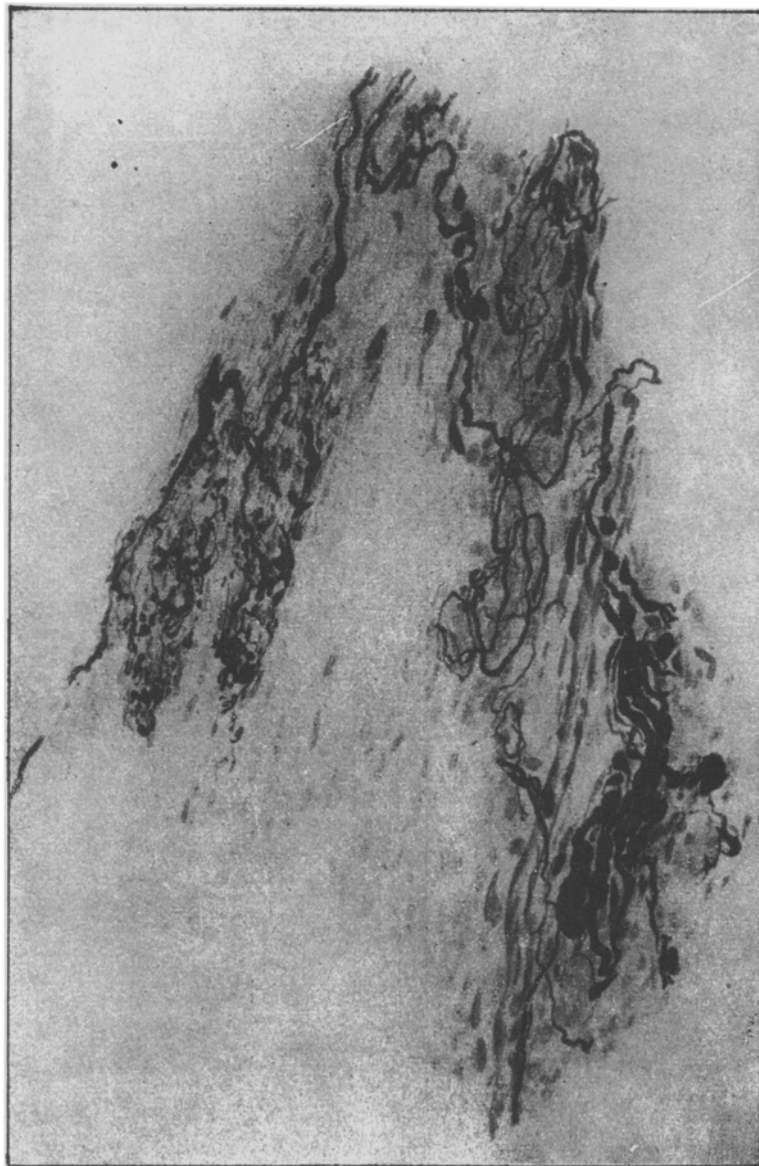


Fig. 1. Severe changes in the lower receptor with hypertrophy of all its structures. In the upper receptor there are signs of destruction with rupture of loops and of end-bulbs and varicose dilatations of the pre-terminal segment of the nerve fiber. Bielschowsky — Gros method. Magnification: ocular 10 x, objective 40 x.

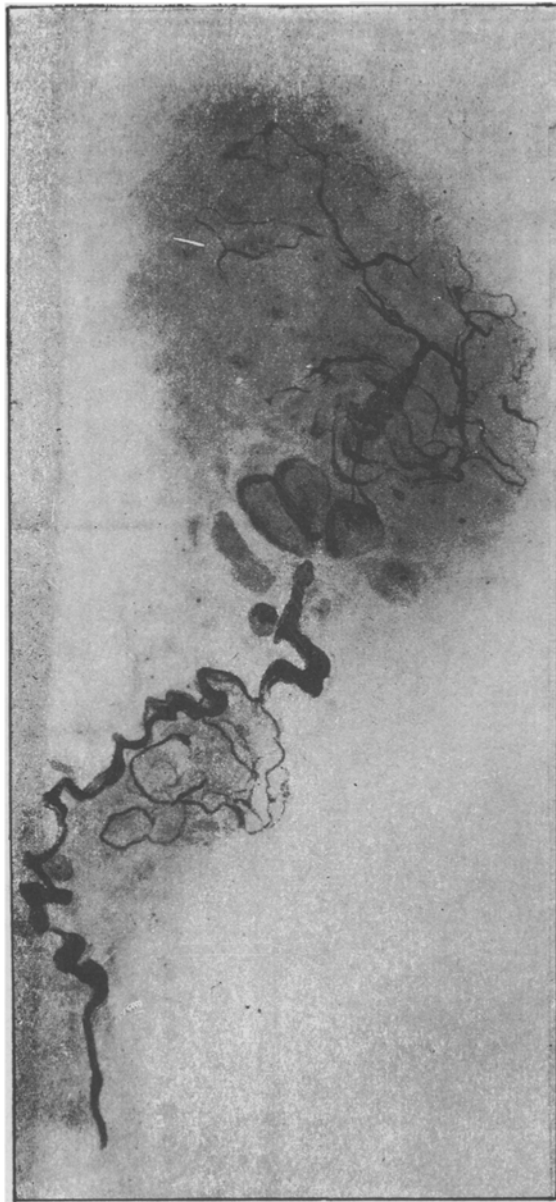


Fig. 2

Fig. 2. Modified receptor in the wall of the anterior vena cava. Disintegration of terminal structures, fragmentation of the conducting fiber and formation of poorly staining spheres of large size are seen. Bielschowsky - Gros staining. Magnification: ocular 15 x, objective 40 x.



Fig. 3

Fig. 3. Modified receptor in the wall of the anterior vena cava. Varicose dilations and swellings of the nerve fiber seen in its preterminal part, widespread hemorrhage in the zone of the receptor. Bielschowsky - Gros staining. Magnification: ocular 10 x, objective 40 x.

In the first place ease of impregnation of the nerve cells and an abundance of nerve cells in the preparations were revealed. Thanks to the high argentophilia an extremely intensive staining in a black color of the receptor apparatus was usually noted, with well differentiated fine structural details.

One of the most common variants of the reactive changes in the receptor endings after irradiation is hypertrophy of the structures of the terminal apparatus. In these cases the terminal endings appear as intensively and homogeneously stained varicose dilatations. Figure 1 illustrates a group of receptor endings in the wall of the anterior vena cava. A severe change is clearly seen in the receptor, with hypertrophy of all its structures; in another ending there are significant changes with signs of destruction, rupture of loops and end-bulbs, and varicose dilatations of the preterminal part.

In addition to increased argentophilia and excessive growth of the terminal endings, the destruction of the terminal structures which is quite often seen must also be regarded as an extremely characteristic change.

Signs of destruction of the receptor endings were observed in the venae cavae, the pulmonary veins and the carotid sinus zone; changes of this sort were not observed in the portal vein.

Figure 2 illustrates a sharply altered receptor with destruction of its terminal structures and fragmentation of the conducting nerve fiber with formation of badly staining fragments of large size.

We must emphasize particularly the description of the state of the afferent fibers in their preterminal part. In these segments of the peripheral nerve fibers are seen the most pronounced changes in the form of a coarsening of the nerve fibers, the formation of extensive accumulations of neuroplasm along their course, resembling globular or spherical swellings, and fragmentation with loss of connecting traces between the separate fragments.

In Fig. 3 is shown a severely modified receptor in the wall of the anterior vena cava with varicose dilatations and hypertrophy of the nerve fiber in its preterminal part. Similar reactive changes are also observed in the medullated nerve fibers of the carotid sinus zone. Here, in many of the receptor endings the preterminal part appears as coarse, intensively stained fibers, black in color, with collections of neuroplasm and extensive varicose dilatations. Some fibers terminate in pin-head swellings with no proper endings, others are broken up into separate fragments, sometimes taking on the appearance of enormous spheres.

During the study of the preparations attention was drawn to the presence in the majority of severe dilatation and distension with blood of the capillaries, with the formation of extensive extravasation of blood into the tissues (see Fig. 3).

It must be emphasized that the morphological changes in the nerve endings described above were met only in the venae cavae, the pulmonary veins and the carotid sinus zone; in the wall of the portal vein the receptor endings were by no means so appreciably modified.

From the results which we obtained it is clearly seen that on the 3rd day after irradiation paranecrotic changes appear in the preterminal and terminal portions of the afferent nerves in the walls of the venae cavae, the pulmonary veins and the carotid sinus zone. These changes are essentially similar to those which have previously been seen by many other workers in various pathological conditions [1, 2, 3, 4, 5], and they are evidently nonspecific in character.

SUMMARY

Experiments were performed on cats. The author studied the condition of receptor apparatus in a number of large blood vessels at the early periods following x-ray irradiation. Pronounced reactive changes of receptors were revealed in the wall of the venae cavae, the pulmonary veins and the synocarotid zones on the third day following the irradiation with the dose of 600 r. These changes were manifested in various morphological pictures from increased argentophilia to complete disintegration of the terminal apparatuses. These changes in the receptors are analogous to those observed formerly by a number of authors in other pathological conditions and are, evidently, nonspecific in character.

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