

DYNAMICS OF THE MORPHOLOGIC CHANGES IN THE INNERVATION
SYSTEM OF THE MENINGES OF DOGS WITH A SEVERE FORM
OF ACUTE RADIATION SICKNESS

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It was established by investigation of the reactions of the central nervous system to the effect of ionizing radiation that in acute radiation sickness disorders of cerebral circulation of the blood and intracranial pressure occur extremely rapidly [2, 3, 6]. The literature contains only an investigation of the effect of x-radiation on the nerve elements of the rat dura mater [1]. In the present work we studied the dynamics of the morphologic changes of the nerve elements of the meninges after irradiation in dogs.

METHOD

The experiment was carried out on 17 dogs. Irradiation was with γ -rays on an EGO-2 device (experimental irradiator) at a dose rate of 239 R/min; the lethal dose of irradiation for the dogs was 350 R; the life span of dogs does not exceed 3-5 days with irradiation in a dose of 900 R, and 9-12 days in a dose of 350 R [4]. Five dogs were irradiated with a dose of 900 R, 10 dogs with a dose of 650 R, and 2 dogs were not irradiated (control). The animals were killed 1 h and 1, 3, 5, 7, and 9 days postirradiation.

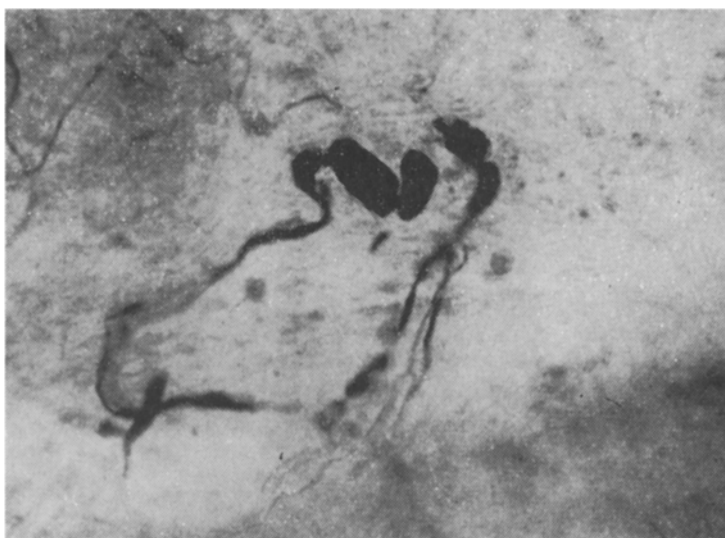


Fig. 1. Disintegration of nerve fiber in pia mater of the brain stem of a dog killed 1 day postirradiation. Staining by Campos' silver impregnation. Objective 40, ocular 5.

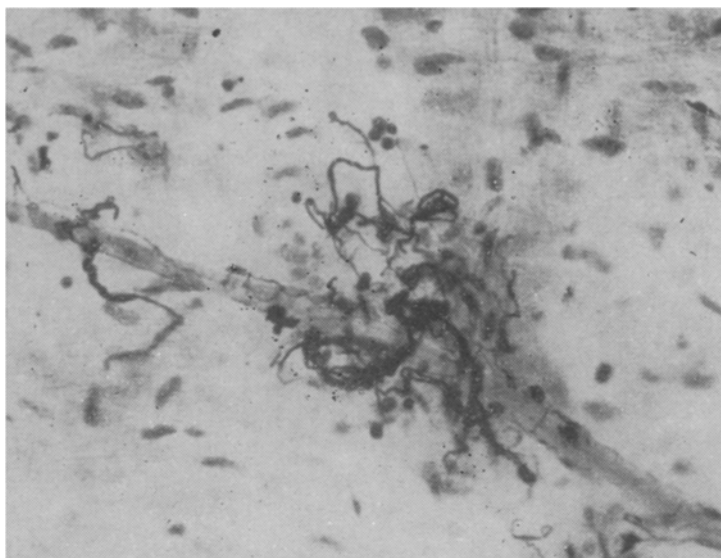


Fig. 2. Receptor element with convoluted preterminals and disintegration of end branches. Pia mater of medulla oblongata of the same dog. Same staining method. Objective 20, ocular 10.

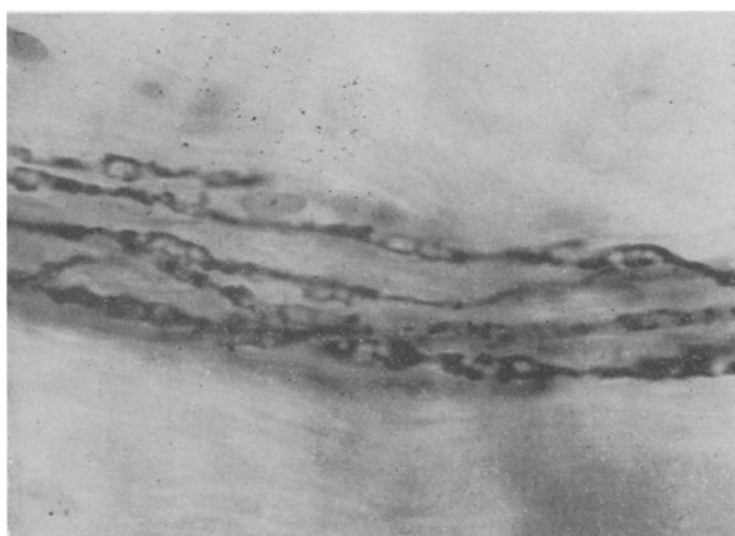


Fig. 3. Pathological changes in the state of the thick medullated fibers. Spinal pia mater. Same staining. Objective 90, ocular 7.

The brain and spinal cord were fixed in 10% neutral formalin. To elicit the nerve elements we used Campos' modification of the Gros-Bielschowsky silver-staining technique. Films of the pia mater were impregnated totally, and from the dura mater we made frozen sections.

RESULTS

At the initial period after irradiation (30-60 min) we noted pronounced argentophilia of the nerve elements, nonuniformity of impregnation, and the development of marked thickenings of the axons of the nerve fibers. In the spinal pia mater we noted vacuolation of the myelin sheaths of the thick medullated fibers. In the receptors of the pia mater of the brain stem we noted distinct swelling of the receptor endings and varicose changes with evident separation of the neurofibrils in the preterminal fibers. After 24 h destructive changes were added to the irritation events. In the pia mater of the brain stem we saw decomposition of the nerve fibers in the area of the constrictions

connecting the varicose swellings (1). In the same areas we encountered receptors with greatly convoluted preterminals and decomposing receptor endings (Fig. 2). Along the course of the fine nonmedullated fibers passing in the walls of the vessels of the base of the brain and in the tissue of the dura mater we found punctate granules. Along with this an appreciable part of the nerve apparatuses was unchanged, especially in the pia mater covering the hemisphere. After three days the increased argentophilia of the nerve elements disappeared and the intensity of silver impregnation declined in comparison with the norm. But the thick medullated fibers passing from the roots of the cranial and spinal nerves, as usual, appeared dark, coarse, with uneven outlines and contained large vacuoles in the myelin sheaths (Fig. 3). The described character of lesion of these fibers persisted until the end of the observations. This phenomenon is similar to coagulation necrosis or "mummification" of nerve fibers when the fiber is necrotizing, but retains its structure upon silver impregnation. Such changes are described in the literature in gross trauma and local ischemia [5, 7]. After three days in the dogs irradiated with a dose of 900 R we observed a marked deterioration of their condition and at the same time phenomena of stimulation and destruction were observed in the innervation system of the meninges. Evident argentophilia of the nerve elements again appeared beginning with the 5-7th day (with irradiation in a dose of 650 R). A significant involvement of all nerve elements in the process was characteristic of this period. Unaltered nerve fibers and receptors were encountered much more rarely. In the pia mater of the brain stem and hemispheres there were numerous destroyed receptors in the form of the remains of tufts, spirals, and clusters. In the dura mater of the superior longitudinal sinus we noted receptors whose preterminals were dotted with dark granules. Vacuolation and lysis of the axons were frequently elicited in the nerve fibers. In spite of the graver clinical state of dogs killed after 9 days, the pathological changes of the innervation elements of the meninges were less expressed than in dogs killed after 7 days.

An analysis of our data and that in the literature permits the assumption that early changes in the innervation elements of the meninges play an important role in the development of disorders of blood circulation in the central nervous system in radiation sickness, since soon after irradiation the morphological changes in the meninges were expressed by hyperemia and dilation of the lumen of the vessels. Destructive changes of the nerve elements arising in subsequent periods of the development of the disease are apparently a source for further aggravation of the hemodynamics and cerebrospinal fluid dynamics in the central nervous system.

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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.