# MICROVASCULAR BED OF THE FASCIA PROPRIA OF THE RAT LOWER LIMB AND ITS RESPONSE TO GAMMA-RADIATION

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Radioactive substances are now being used in different branches of man's practical and scientific activity. There is therefore an increased risk of exposure to different types of ionizing radiation (IR) [2, 7, 10].

According to published reports, early postradiation responses develop immediately after irradiation and are characterized morphologically by signs of acute disturbances of the hemodynamics, and also by nonspecific changes in tissue ultrastructure [2, 7, 4]. The response of the hematopoietic organs to irradiation has been studied in detail. However, a considerable proportion of genetically related structures of connective-tissue formations (fascias) has attracted comparatively little attention of research workers.

Different types of connective tissue (CT) differ in their radiosensitivity. Loose CT is less resistant than dense, whereas late changes are found much more frequently in dense CT, which contains more fibrous structures [9, 11, 13]. The question arises of the mechanisms of changes in the fibrous structures during radiation injuries and the effect of vaso-tissue relations on the development of radiation changes in CT.

The aim of this investigation was to study the microcirculatory bed (MCB) of the fascia propria of the rat leg (FPL) under normal conditions and after changes induced by a single exposure to above-lethal doses of gamma-rays.

## EXPERIMENTAL METHOD

Experiments were carried out on 20 noninbred albino rats weighing 300-320 g. The animals were exposed to a single dose of whole-body irradiation of 10,000 R, with a total power of 517.67 R/min, from a gamma-ray source located on the left side along the center of the body and at a distance of 0.34 m, for 19 min 19 sec. The animals were killed with ether vapor 5 min after irradiation. The left FPL of the irradiated and intact rats was fixed in 12% neutral formalin. MCB was studied in fragments of FPL, separated into layers and impregnated with silver nitrate by V. V. Kupriyanov's method, and sections stained with hematoxylin and eosin; transcapillary in jection of the vessels with ink-gelatin mass through the abdominal aorta also was used. The sections were studied under the BIOLAM microscope, using a screw-operated MOV-15 ocular micrometer giving overall magnification of 300 times for morphometry of the vessels. The results were subjected to statistical analysis. The significance of differences between the parameters studied was estimated by Student's t test at the $p < 0.05$ level.

## EXPERIMENTAL RESULTS

With the aim of studying morphological changes in MCB of FPL of rats exposed to gamma-rays, the first step was to study the intramural vascular bed of this fascia under normal conditions.

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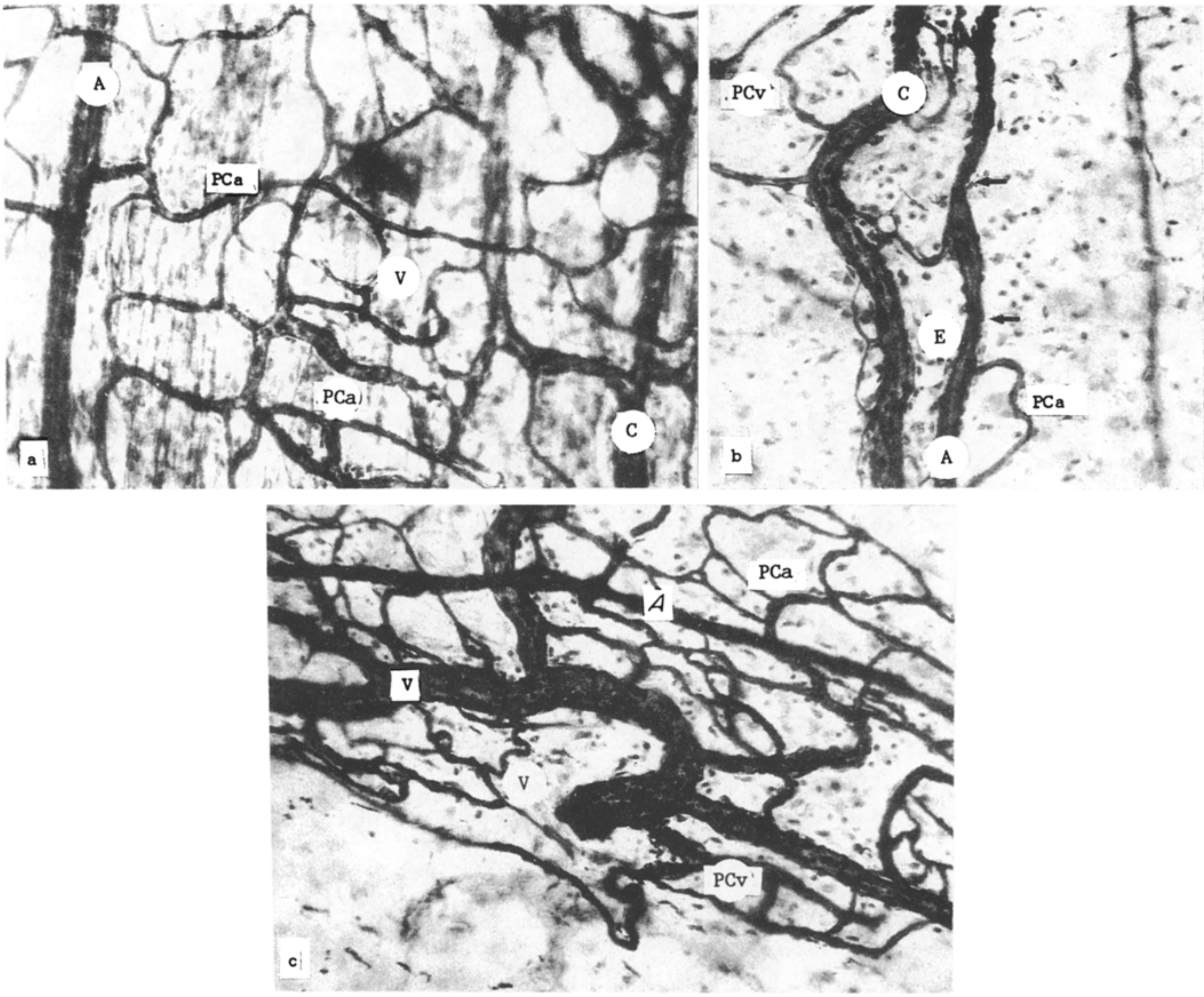


Fig. 1. MCB of rat FPL under normal conditions and after irradiation by gamma-rays: a) fragment of microvascular net of FPL of intact rats (A — arteriole, V — venule, PCa — precapillary, C — capillary, PCv — postcapillary); b, c) fragments of microvascular net of FPL of irradiated rats (A — arteriole with wavelike course, arrows indicate regions of local spasm; V) tortuous venule. PCa — precapillary, C — tortuous capillary, PCv — tortuous postcapillary with uneven diameter, E — erythrocytes. Magnification 160×. Impregnation with silver nitrate.

The vascular nets in different layers of FPL differed in their development. For instance, in the suprafascial and subfascial layers, consisting mainly of loose CT without definite orientation of the fibers, the distribution of the vessels was mainly in the form of trunks.

Against the background of avascular zones bundles of vascular tracts could be seen. They were composed of all the components of MCB. Arterioles were accompanied by one or two venules. Precapillaries were given off at an acute angle and were accompanied by postcapillaries, but most frequently arterioles and venules followed an independent but parallel course. Postcapillaries exhibited moderate tortuosity. The capillaries were oriented along the vascular trunks, to form paravasal tracts. Besides vascular tracts, vascular nets formed of large loops, with capillaries pursuing a linear and wavelike course also could be seen. All the microvessels were uniform in diameter and had distinct and even outlines of their walls. The average diameter of the venules was 14.4% greater than the diameter of the corresponding arterioles.

TABLE 1. Morphometric Parameters of Vessels of MCB of Albino Rat FPL under Normal Conditions and after Above-Lethal Irradiation

| Group of animals | Diameter | | | | |
|---|---|---|---|---|---|
| | arterioles | precapillaries | ccapillaries | postcapillaries | Venules |
| Control | 19,04±<br>±0,83 | 12,97±<br>±0,38 | 6,09±<br>±0,33 | 15,29±<br>±0,56 | 22,22±<br>±0,87 |
| Gamma-irradiation | 38,02±<br>±1,01* | 16,96±<br>±0,23* | 9,20±<br>±0,02* | 22,02±<br>±0,55* | 51,76±<br>±1,08* |

**Legend.** *$p < 0.05$ compared with control.

The intrafascial vascular net of the rat FPL was richer in microvessels than the suprafascial nets. Arterioles could be traced in the dense layer of FPL without accompanying satellite venules, but if they were so accompanied the venules lay at a considerable distance from the arterioles. The trunk vessels as a rule ran parallel to the collagen bundles and pursued a linear course (Fig. 1a). Precapillaries and postcapillaries crossed the collagen fibers. The exchange component of MCB consisted of a finely looped azure capillary network. A study of the walls of the blood microvessels of the rat FPL revealed no significant changes in their histological structure. Arteriolo-venular anastomoses varied in form.

Thus the architectonics and morphology of microvessels of the rat FPL depend on the structural features of the fascia itself, an important role being played by the character of distribution of the collagen fibers.

Investigation of the experimental material showed that the structure of the fascias, the vaso-tissue relations, and the direction and shape of the vessels in animals exposed to irradiation did not differ on the whole from those in the control rats, in agreement with the results of previous investigations. Signs of changes in the geometry of the vessels and an increase in their density developed according to the time elapsing after irradiation [1, 6, 7]. In our experiments the architectonics of the venular part of MCB of the FPL of the irradiated rats also underwent a series of changes. For instance, the capillaries and postcapillaries acquired a highly tortuous, and the venules a wavelike course. The architectonics of the afferent component was unchanged. These changes were characteristic of both suprafascial and subfascial vascular nets (Fig. 1b, c).

The vessels of the dense layer of the fascia, where their general orientation and the direction of their course were preserved, were more resistant to the action of gamma-radiation. This was evidently due to the particular resistance of the dense tissue to IR. Collagen fibers were intimately connected with the vessels, and apparently kept them in place. Loose subfascial and suprafascial layers exhibited more marked changes under the influence of radiation. Destructive changes in the tissue involved restructuring of the architectonics of the venular component, as being more labile.

Microscopic investigation of the rat FPL after gamma-ray irradiation revealed vascular, intravascular, and extravascular changes. The most marked changes were disturbances of the vessels in the form of irregularity of their diameters, tortuosity of the capillaries, postcapillaries, and venules, and microaneurysms, disturbances of the typical relations between the diameters of the arterioles and the accompanying parallel venules were detected. An increase in the diameters of all components of MCB was observed (Table 1). The arterioles and venules lost the clarity of their outlines throughout, and regions of local spasm were found. Local dilatation of regions of the arterioles and venules can be explained by paresis of the smooth muscle cells. The nuclei of the endothelial cells under these circumstances lost their clarity of outline and their oval shape, and lay a considerable distance apart. In different regions of MCB intravascular aggregation of erythrocytes could be seen. The extravascular changes consisted of perivascular edema and diapedesis of erythrocytes into the surrounding tissues.

Against this background, some blood vessels were relatively unchanged. The mosaic character of this restructuring of MCB of the rat FPL under the influence of radiation is evidence of the selective sensitivity of individual vascular regions. It can be tentatively suggested that this selectivity is determined by the functional state of these vessels at the time of irradiation [8]. It must be emphasized, however, that as a whole the endothelium of the microvessels of animals differs from the corresponding structures in man by their higher physiological resistance [2, 3, 5].

Thus the structural components of MCB, exposed to extremal conditions, respond uniformly in principle to IR by dilatation. However, the degree of the change in diameter of the vessels differs in all the vascular components. Maximal dilatation is found in venules and arterioles, evidently because of damage to their nervous apparatus [14, 15]. Second place in the intensity of dilatation is occupied by the capillaries. It can be postulated that these vessels change their diameter as a result of hemodynamic influences, and also because of swelling and subsequent edema of the endothelial cells. The high degree of dilatation of the postcapillaries compared with the corresponding changes in the precapillaries can be explained by the greater lability of the structures of these vessels during exposure to extremal factors [4, 8, 12].

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