THE NATURE OF KURLOV'S CORPUSCLES

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An increase in the percentage of monocytes and monocyte-like cells with Kurlov's corpuscles is found in the blood and bone marrow of guinea pigs, together with a sharp increase in size of the corpuscles themselves, after irradiation and after administration of large doses of cytostatic preparations.

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In 1888, M. G. Kurlov described a distinctive type of inclusion in the agranulocytes of the guinea pig which were subsequently named Kurlov's corpuscles. Some investigators [2, 3] regard them as secretory vacuoles, while others [6] consider that they are abnormal inclusions (but not related to parasites), a third group [4] points to the similarity between the corpuscles and protozoa, and finally, a fourth group [5] regard them as agents of low pathogenicity readily ingested by the reticuloendothelial cells.

Because of the conflicting nature of data in the literature, we decided to investigate the nature of Kurlov's corpuscles.

EXPERIMENTAL METHOD AND RESULTS

When studying the reaction of the blood system of guinea pigs to irradiation in large doses (450-10,000 rad) on betatrons we concentrated on changes in the percentage of monocytes with Kurlov's corpuscles in the blood and on changes in the corpuscles themselves in the early periods after irradiation. The number of monocytes with corpuscles increased after 30-90 min by 3.5-13 times, and on the 2nd day by 1.5-12 times over the background level. Since this phenomenon coincided in time with the development of true lymphocytopenia and monocytopenia, we concluded that the increase in percentage of such monocytes may depend on some processes changing their functional state and associated with radiation damage.*

After irradiation many large corpuscles appeared, occupying nearly the whole cytoplasm of the cells containing them. The corpuscles had a coarse fibrous structure or contained large granules or rods staining metachromatically with thionine (Fig. 1, a-d). The larger the granules, the fewer their number. Large granules were also found against the colorless background of the vacuole of the Kurlov's corpuscle. Large corpuscles staining homogeneously and resembling hyaline spheres were also found (Fig. 1e; Fig. 2a). In the bone marrow preparations cells could be observed in which these hyaline-like formations had a tendency to separate from the nucleus along with vacuolated cytoplasm (Fig. 1e). Finally, empty corpuscles were seen, with no hint of an internal structure (Fig. 2b).

The study of changes in the nuclei of cells containing Kurlov's corpuscles showed that these changes are dependent on the dimensions of the corpuscles themselves: the larger the corpuscles, the more intensively the nucleus was displaced toward the periphery and the more pycnotic its appearance. If two large corpuscles were present, the nucleus appeared compressed from both sides. Sometimes Kurlov's corpuscles were found in the center and the nucleus was in a state of karyorrhexis and lysis (Fig. 1b). More rarely, corpuscles were seen to develop within the cell nucleus, part of the nucleus appearing to have been perforated by a bullet, and in the empty vacuole thus created the azurophilic structure of the corpuscle could be seen (Fig. 2c).

After administration of cytostatic preparations, an increase in the number of blood and bone marrow cells with Kurlov's corpuscles also was observed. The corpuscles were found not only in monocytes, but also in the monocyte-like cells of the marrow—hemohistioblasts, polyploid giant hemohistioblasts (Fig. 2c), macrophages, and reticulum cells (Fig. 2d).

*According to our data, Kurlov's corpuscles are found much more frequently in the monocytes of female guinea pigs (9.1 ± 1.7%) than of males (0.7 ± 0.2%).

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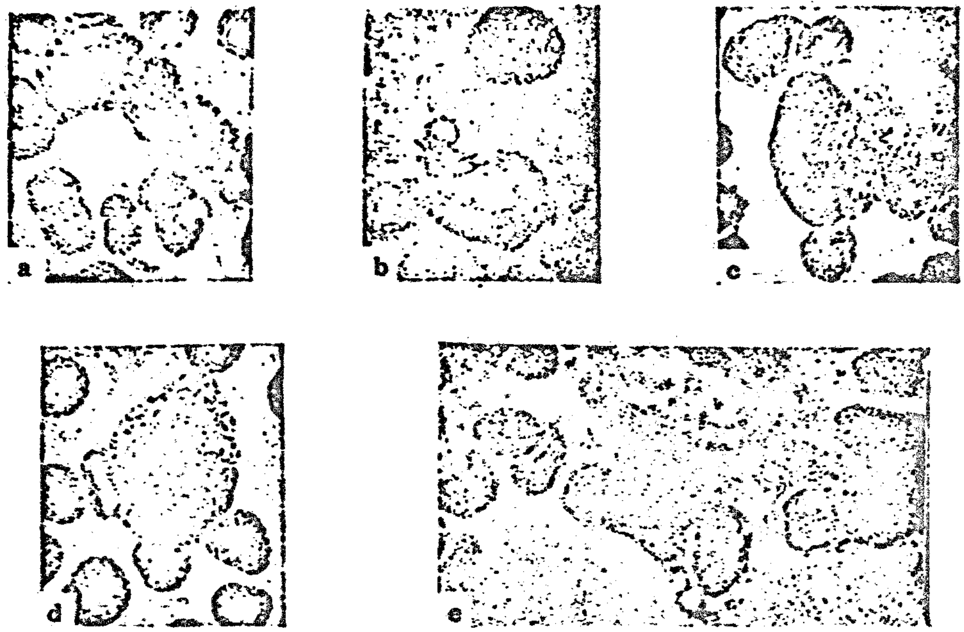

Fig. 1. Types of Kurlov's corpuscles in acute radiation sickness. a) Monocytes with Kurlov's corpuscles in blood of a guinea pig 60 min after irradiation in dose of 6,300 rad; b) monocyte with Kurlov's corpuscle with coarse fibers in bone marrow on 11th day after irradiation in dose of 900 rad; c) Kurlov's corpuscle with coarsely granular structure on 5th day after irradiation in dose of 6,300 rad. Cell nucleus displaced and pycnotic. Vascuolation of cytoplasm; d) the same on 2nd day after irradiation in dose of 900 rad (blood). Pycnosis of nucleus, considerable enlargement of Kurlov's corpuscle, coarse structure; e) monocytes with corpuscle in bone marrow on 5th day after irradiation in dose of 4,500 rad. Corpuscles resemble hyaline spheres in appearance. Azure II-eosin. Objective, immersion 1/12, ocular 6 x.

Cells with Kurlov's corpuscles were particularly numerous after administration of large doses of urethane. For instance, in one guinea pig the number of monocytes with corpuscles was 6%, while on the 2nd day after administration of urethane (800 mg/kg) the number had increased to 84%, and in another animal the number of cells with corpuscles rose from 3 to 79% on the day after administration of urethane (2,00 mg/kg). Bone marrow films from these animals revealed numerous monocyte-like cells with corpuscles (as many as 8–12 per field of vision). The cells were reticular in nature and contained large Kurlov's corpuscles (Fig. 3).

The results of the histochemical investigation showed that the Kurlov's corpuscles consist mainly of a protein-polysaccharide complex with the presence of high-polymer acid mucopolysaccharides, and that they are vacuoles whose appearance is associated with physiological and pathological aging of cells of reticulo-histiocyte nature. Since acid mucopolysaccharides can undergo hydration, their accumulation evidently facilitates the formation of the vacuole of the Kurlov's corpuscle.

Our hypothesis that the Kurlov's corpuscles in the monocytes and other cells of reticulo-histiocyte nature arise as a result of physiological and pathological aging is based on the following facts. In the period of the acute leukocytic response after irradiation (the early phase of leukocytosis), the absolute number of lymphocytes falls, but the percentage of agranulocytes containing Kurlov's corpuscles increases by 3–13 times (over the background level). The appearance of very large corpuscles, occupying nearly the whole of the cytoplasm, in cells of the blood and bone marrow was always accompanied by severe compression of the nucleus, with signs of pycnosis, lysis, and sometimes of karyorrhexis. These changes were also well defined in monocyte-like cells [illegible] in the bone marrow after administration of massive doses of urethane and markophan [illegible]. [illegible] of the bone marrow undergoing differentiation into cells of the myeloid series, sometimes no Kurlov's corpuscles were found. [illegible]

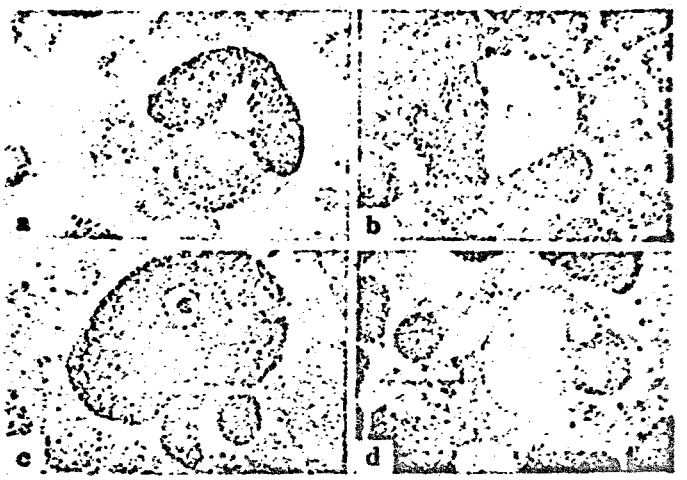

Fig. 2. Types of Kurlov's corpuscles in radiation sickness and after administration of cytostatic preparations. a) Monocyte with pycnotic nucleus, vacuolated cytoplasm, and Kurlov's corpuscle resembling a hyaline sphere in the bone marrow on 7th day after irradiation in dose of 900 rad; b) empty Kurlov's corpuscle in a blood monocyte 60 min after irradiation in dose of 1,000 rad; c) Kurlov's corpuscle in nucleus of bone marrow hemohistioblast after administration of urethane and 20 h after irradiation in dose of 2,000 rad; d) Kurlov's corpuscle in bone marrow macrophage in chronic radiation sickness.

Fig. 3. Monocyte-like cells with Kurlov's corpuscles in bone marrow of guinea pig 24 h after administration of urethane in dose of 2,000 mg/kg.

tion of acid mucopolysaccharides, metachromasia, and the positive PAS reaction are also evidence supporting the view that Kurlov's corpuscles are vacuoles filled with a mucoid substance with predominance of bound water (resembling the phenomenon of mucoid edema). Experiments on guinea pigs exposed to chronic irradiation in our laboratory (V. I. Teterina) revealed the development of acute leukemias (hemocytoblastoses) and hypoplastic states of hemopoiesis but yielded no information on the problem discussed in this paper.

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