

# HISTOCHEMICAL CHANGES IN THE ENTEROCHROMAFFIN CELLS OF THE DUODENUM IN ACUTE RADIATION SICKNESS

N. M. Nemenova, V. M. Manteifel', and G. A. Chernov

Central Order of Lenin Institute of Hematology and Blood Transfusion,  
Ministry of Health of the USSR, Moscow

(Presented by Active Member AMN SSSR N. A. Kraevskii)

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The great importance of serotonin (5-hydroxytryptamine) in the pathogenesis of the hemorrhagic syndrome, including that arising in radiation sickness, has now been established [2, 3, and others]. Insufficient research has, however, been done on the mechanism of disturbance of serotonin metabolism after exposure of the organism to ionizing radiations. Only a few reports have appeared in which, by the use of biochemical methods, a decrease in the serotonin content in the intestine of guinea pigs and rats and a change in the activity of certain enzymes taking part in serotonin metabolism (5-hydroxytryptophane decarboxylase and monoamine oxidase) have been detected after whole-body irradiation with x-rays.

In the accessible literature we found no reference to the study of the influence of irradiation on the state of the enterochromaffin cells (cells of Kultschitzky), on the functional integrity of which depends the level of the extra-cerebral serotonin. When taking up this particular investigation, we considered that the histochemical study of these cells may shed light on the mechanism of disturbance of the serotonin metabolism in radiation sickness.

The enterochromaffin cells were first described by Kultschitzky in the mucous membrane of the gastro-intestinal tract in 1897[11]. It was later shown [6, 7, 8, 9] that the principal function of these cells is to produce serotonin. We can therefore use their state to judge the severity of disturbances of serotonin metabolism.

## EXPERIMENTAL METHODS

Acute radiation sickness was produced in guinea pigs and rats by single whole-body irradiation with filtered (0.5 mm Cu + 1 mm Al) x-rays from an RUM-3 apparatus under the following conditions: voltage 180 kv, current 15 ma, dose rate 12 r/min, focus distance 60 cm. Rats were irradiated with a dose of 750 r (LD<sub>100</sub>) and guinea pigs with a dose of 500 r (LD<sub>100</sub>).

The animals were sacrificed on the 1st, 3rd, 5th, 7th, 9th, and 11th days after irradiation. Pieces of the first part of the duodenum were taken for investigation. The enterochromaffin cells were demonstrated by Masson's method (Hamperl's formula), using Fontana's solution. A control chromaffin reaction was also carried out by the Pfeiffer-Jarisch method, a specific histochemical test for polyphenols, aminophenols, and o- and p-polyamines.

## EXPERIMENTAL RESULTS

In animals sacrificed in the acute stage of radiation sickness (7th-11th days after irradiation), autopsy revealed the typical picture of radiation lesions (aplasia of bone marrow, atrophy of lymphoid tissue, hemorrhage into the lungs and gastro-intestinal tract of the guinea pigs, and so on). Microscopic examination of sections of the intestine from the very first days after irradiation revealed changes in the mucous membrane, consisting of vacuolation of epithelial cells, necrobiotic changes with detachment of destroyed areas, and extensive focal hemorrhages.

The number and character of distribution of the enterochromaffin cells in the mucous membrane of the duodenum in a guinea pig before irradiation can be seen in Fig. 1. The majority of these cells are concentrated in the villi and crypts of the mucous membrane. After irradiation, severe disturbances in the state of the enterochromaffin cells were revealed histochemically. During the first day after irradiation there was a slight increase in the number of these cells and in their granularity (Fig. 2). The number of enterochromaffin cells then gradually fell; at the climax of radiation sickness (9th day) a particular sharp fall in their number was observed, as seen in Fig. 3. It must be pointed out that, in addition to this decrease in the number of enterochromaffin cells, in the latter stages of radiation sickness (9th-11th

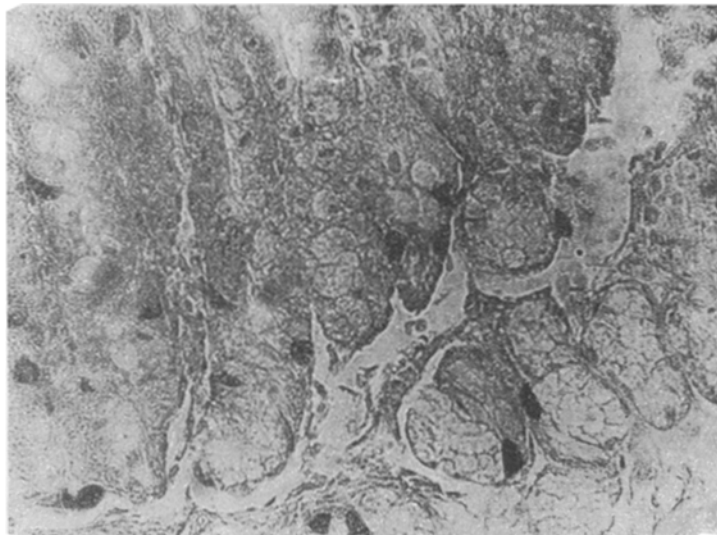


Fig. 1. Enterochromaffin cells in the mucous membrane of the duodenum of a guinea pig before irradiation.

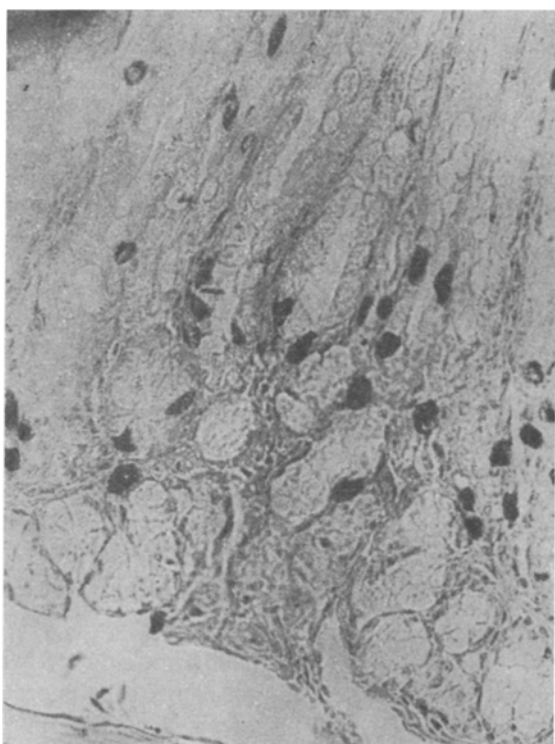


Fig. 2. Enterochromaffin cells in the mucous membrane of the duodenum of a guinea pig soon after irradiation.

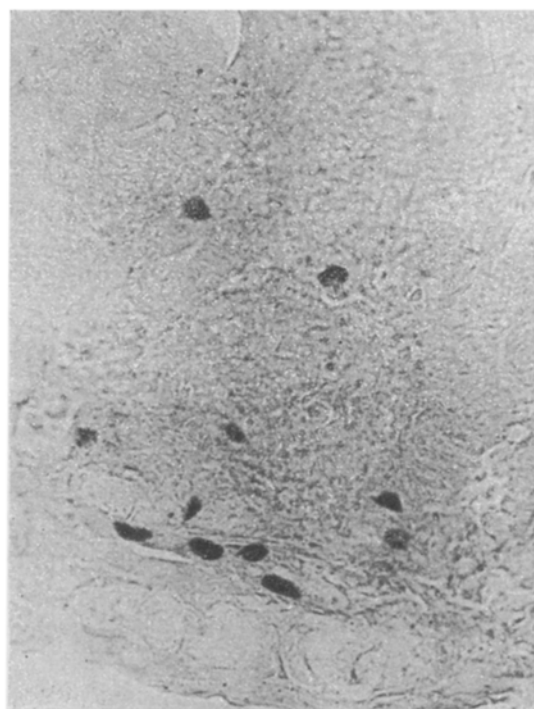


Fig. 3. Enterochromaffin cells in the mucous membrane of the duodenum of a guinea pig at the climax of radiation sickness.

days) a decrease was observed in the number of granules present in these cells, which may also indicate a disturbance of the functional integrity of these cells. Similar changes were found in our experiments on rats.

The decrease in the number of enterochromaffin cells in the intestine during radiation sickness may be associated with a disturbance of the regeneration of the elements of the intestinal mucosa after irradiation, a fact which has

frequently been reported in the literature [1, 5, 10]. However, when discussing the causes of this decrease in the number of enterochromaffin cells in the intestinal mucosa after exposure to ionizing radiations, we must take into account the findings of several workers [7, 8, 9] that in certain conditions (as a result of the action of reserpine and other alkaloids, for example) the decrease in the number of enterochromaffin cells was related histochemically to the loss of their ability to reduce ammoniacal silver without a reducing agent, i.e., to the conversion of the enterochromaffin cells into pre-enterochromaffin, which possess only the property of argyrophilia and not that of argentophilia, and are unable to synthesize serotonin.

If these observations are taken into consideration, it may be suggested that in acute radiation sickness too, the decrease in the number of enterochromaffin cells in the intestinal mucosa, which we detected histochemically, may be dependent not only on the disturbance of their proliferative processes, but also on the inhibition of the process of conversion of the pre-enterochromaffin cells into enterochromaffin, associated with the loss of their ability to synthesize serotonin. This hypothesis agrees well with the observations of G. A. Chernov and L. M. Morozovskaya, who showed that in acute radiation sickness there is a decrease in the activity of 5-hydroxytryptophane decarboxylase and in the serotonin concentration in the blood, which also indicates a disturbance of the synthesis of serotonin in the intestine.

It may be concluded from these facts that a change in the number of enterochromaffin cells and in their content of chromaffin granules takes place in radiation sickness irrespectively of the mechanism of this process, and is a morphological expression of profound disturbances in the serotonin metabolism, to which considerable importance is attached at the present time not only in the regulation of hemostasis, but also in several other functions of the body (the activity of the central nervous system, the gastro-intestinal tract, the kidneys, and so on).

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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.

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