AUTORADIOGRAPHIC INVESTIGATION OF PROLIFERATION AND MIGRATION OF THE INTESTINAL EPITHELIUM AFTER GASTRECTOMY

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After gastrectomy by the Billroth I method compensatory and adaptive changes take place in the intestinal mucosa, reflected morphologically as hyperplasia of the epithelial cells accompanied by an increase in their rate of renewal. The character of these changes is identical in all parts of the intestine.

In the process of compensation and adaptation after gastrectomy an important role is played by the intestine, the specific digestive and absorptive functions of which are enhanced in partial replacement of the disturbed gastric function [5, 6, 3].

Enhancement of the specific function of the intestine, due to an increase in the quantity of food to be digested [7] or to resection [8, 2, 4], is accompanied by an increase in the rate of cell proliferation (hyperplasia) and in the rate of renewal of the epithelium. Meanwhile the morphological substrate of compensatory adaptation of theintestinal epithelium after gastrectomy has so far received little study [1]. In particular, no investigations of the proliferation and migration of enterocytes after gastrectomy are described in the literature.

EXPERIMENTAL METHOD

To study the effect of gastrectomy on proliferation and migration of the intestinal epithelium an autoradiographic study was made of the mucous membrane of the duodenum, jejunum, ileum, and large intestine of rats after gastrectomy. A Billroth I type of gastrectomy was performed on rats weighing 100-120 g. The animals were subdivided into three groups, with eight rats in each group: the rats of group 1 were sacrificed 1 month and those of group 2 were sacrificed 3 months after gastrectomy, while group 3 (intact rats) was the control. The rats were decapitated 1-72 h after receiving an injection of thymidine-H^3 in a dose of 0.5 μCi/g body weight. The specimens were prepared and the index of labeled nuclei (ILN) was calculated by the method described previously [4]. The number of crypt cells was counted by the method of Wimber and Lamerton [9].

EXPERIMENTAL RESULTS

ILN for the epithelium of the duodenal crypts 1 month after gastrectomy showeda significant increase, reflecting an increase in the proliferative activity of the intestinal epithelium. A considerable proportion of the cells of the villi was labeled 24 h after injection of thymidine-H^3.

One month after gastrectomy, an increase in ILN was thus observed in the crypt cells of the rats. Counting the number of crypt cells showed an increase of 18% relative to the control in the cell population.

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Three months after resection and in the early period after injection of thymidine-H^3 the value of ILN was only slightly different from the control. However, considering that the cell population of the crypt increased by 47.4% during this time, it follows that the absolute number of proliferating cells was increased. It thus follows that many more cells were sloughed off into the lumen than in the control.

In the jejunum 1 month after gastrectomy there was a small decrease in the value of ILN, but since it was accompanied by an increase in the cell population of the crypts, in this situation there was probably no decrease in the absolute number of proliferating cells.

Three months after gastrectomy a small increase in the value of ILN for the crypts in the jejunum of the rats was observed, accompanied by an increase of 17.3% in the cell population. Hence it can be concluded that the proliferative power of the epithelium was considerably increased.

ILN of the crypts in the ileum also was increased 1 month after gastrectomy. This increase was accompanied by an increase in the cell population of the crypts and in the rate of migration of the cells of the villi. For instance, 72 h after injection of thymidine-H^3 ILN of the villi of the control animals was over 25%, but for the gastrectomized rate 1 month after the operation it was only 5%. The decrease in ILN in the cells of the villi took place faster in the gastrectomized rats, indicating a faster rate of their renewal.

Three months after gastrectomy ILN of the crypts was lower than 1 month after the operation, but it was still higher than in the control animals.

The population of crypt cells in the rats 3 months after gastrectomy was 37.3% higher than in the control. The rate of migration of the cells was the same as 1 month after gastrectomy.

The changes in proliferation and migration of the epithelium of the crypts was similar in character in the large intestine to that in the ileum. A marked increase in ILN of the crypt cells was observed 1 month after the operation and was accompanied by a tendency for the number of these cells to fall. Meanwhile, rapid migration of the cells from the crypts to the surface was observed. For example, after 24 h in the control animals solitary cells were observed in the surface epithelium, whereas ILN in the gastrectomized rats was above 20%. ILN of the surface epithelium of the control animals 72 h after injection of thymidine-H^3 was increased to about 20%, while in the gastrectomized rats it was only a little above 10%. In other words, many of the cells in these animals had already left the epithelial layer.

Three months after gastrectomy the number of cells was increased by 24%. However, the relative number of proliferating cells was somewhat reduced, as shown by the decrease in ILN of the crypts. The rate of migration of the cells to the surface and their desquamation into the lumen also were slightly reduced, but were still much higher than in the control animals. Autoradiographic study of the proliferation and migration of the intestinal epithelium of the rats after Billroth I gastrectomy showed that the character of the changes taking place was the same in all parts of the intestinal mucosa.

One month after gastrectomy ILN was considerably increased in the crypts of the duodenum, ileum, and large intestine. This increase was accompanied by an increase in the cell population of the crypts.

Three months after gastrectomy there was a further increase in the cell population of the crypts, but the increase itself was much smaller. ILN for the crypt cells at this period was reduced but was still above the control level everywhere.

The time of complete renewal of the intestinal epithelial cells after gastrectomy was shorter than in the control.

It can thus be concluded that one of the morphological manifestations of compensatory adaptation in the intestine is hyperplasia of the epithelial cells, accompanied by an increase in their rate of renewal.

LITERATURE CITED

1. L. I. Aruin, Uchen. Zapiski Tartu. Univ. Trudy Med., 18, No. 215, 132 (1968).
2. N. P. Bochkov, Byull. Éksperim. Biol. i Med., No. 3, 76 (1959).
3. K. A. Zufarov, Current Problems in Adaptation [in Russian], Tashkent (1970).
4. K. A. Zufarov and I. M. Baibekov, Arkh. Anat., No. 6, 36 (1971).
5. S. I. Filippovich, Adaptive Processes in Disturbances of the Activity of the Digestive System [in Russian], Moscow (1962).

6. S. I. Filippovich, N. Sh. Amirov, T. V. Volkova, et al., Compensatory Processes in the Digestive System after Resection of the Stomach and Small Intestine [in Russian], Moscow (1963).
7. A. B. Cairnie and R. E. Bentley, Exp. Cell Res., 46, 428 (1967).
8. M. R. Loran and T. T. Crocker, J. Cell Biol., 19, 285 (1963).
9. D. R. Wimber and L. F. Lamerton, Radiat. Res., 18, 137 (1963).