REPAIR AND DIFFERENTIATION OF A PIECE OF SMALL INTESTINE GRAFTED INTO THE FUNDUS OF THE RAT STOMACH

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UDC 612.6.02:612.33

Repair processes in a graft of mucous membrane of the small intestine transplanted into the fundus of the rat stomach were studied morphologically in the region of the gastrointestinal suture and at a distance from it. Epithelization of the wound surface by both gastric and intestinal epithelium was observed after 10-12 days. After 30-40 days the connective tissue in the region of the anastomosis was completely covered with newly formed intestinal and, to some extent, gastric epithelium, separated by a clearly marked boundary. The active regeneration of the intestinal graft, with a normal state and a high degree of differentiation of the intestinal epithelium 4-6 months after the operation gave evidence of its viability. The existence of secondary atrophic changes in the mucous membrane of the graft 8-14 months after the operation indicated exhaustion, evidently through overstrain and prolonged adaptation of the intestinal epithelium to inadequate conditions. No evidence of metaplasia of the intestinal graft into epithelium of gastric type could be found either during reparative regeneration or in the course of its prolonged function.

Intestinal epithelium arising in the human stomach under pathological conditions (atrophic gastritis, achylia, etc.) functions normally, is capable of contact digestion and absorption [6, 7], and may even act as the cause of malignant tumors [8]. It was decided to study the fate of a graft of mucous membrane of the small intestine transplanted into the fundus of the stomach with normal acidity.

The object of the investigation was to examine the fate of such a graft and the possibility of its metaplasia.

EXPERIMENTAL METHOD

Operations were performed on 40 rats weighing 180-220 g. After laparotomy the stomach and omentum were brought into the operation wound. A graft measuring 1.0 × 0.8 cm was excised from the region of the greater curvature, at a distance of 3-4 mm from the forestomach. The opening in the stomach was covered with a gauze towel soaked in warm physiological saline.

A piece 1 cm long was excised from the proximal part of the jejunum, carefully divided longitudinally, and preserving its vascular pedicle, it was sutured in the opening made in the stomach wall by seromuscular sutures.

After peritonization with omentum the stomach was replaced in the abdomen. The ends of the resected intestine were sutured end to end. The abdominal wall was closed in layers without drainage.

The stages of reparative regeneration of the gastric mucous membrane and the transplanted intestine were studied in the region of the gastro-intestinal suture and the state of the intestinal graft also was studied at intervals between 24 h and 14 months after operation. The material for testing was examined by general morphological, histochemical, and electron-microscopic methods.

Department of Histology and Morphological Group, Central Research Laboratory, Tashkent Medical Institute. (Presented by Academician of the Academy of Medical Sciences of the USSR A. P. Avtsyn.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 77, No. 2, pp. 89-92, February, 1974. Original article submitted April 12, 1973.

Fig. 1

Fig. 2

Fig. 1. Alkaline phosphatase activity in epithelium covering surface of granulation tissue 10 days after transplantation of piece of small intestine into stomach wall. Stained by Gormori's method, objective 20, homal 5.

Fig. 2. Villi and crypts of intestinal graft near its junction with gastric mucous membrane 30 days after operation. FAS reaction, objective 20, homal 5.

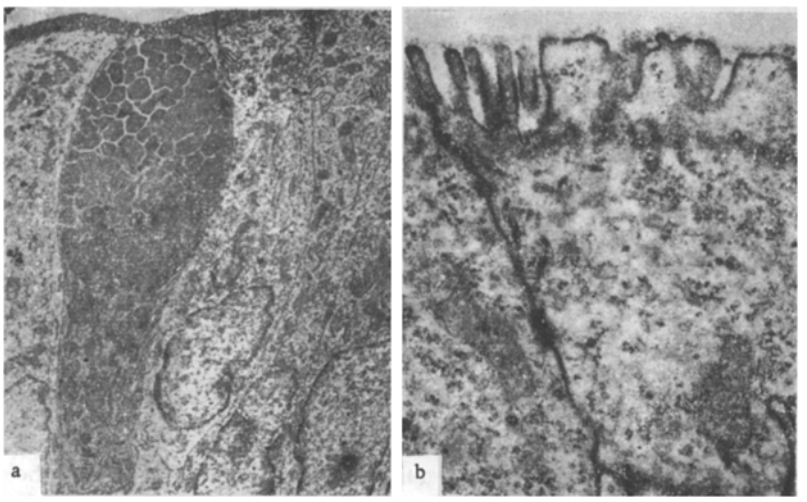

Fig. 3. Ultrastructure of intestinal graft 6-12 months after transplanatation: 1) well-marked microvilli of plasma cells, numerous contours of granular reticulum and mitochondria, and goblet cells with typical structure in cytoplasm (12,000 ×); b) 12 months after transplantation: reduced functional activity of intestinal epithelium; prismatic cell with modified microvilli and reduced number of cytoplasmic membranous structures (35,000 ×).

EXPERIMENTAL RESULTS

Reparative regeneration of the mucous membrane of the stomach and the intestinal graft in the region of the gastrointestinal suture took place by the spread of epithelium from the gastric and intestinal mucous membranes over the wound surface. All the principal features of normal posttraumatic regeneration characteristic of both types of epithelium were preserved [2-5].

Stimulation of mitotic division of the cervical and crypt cells at the edge of the wound, an increase in their number, and growth of young connective tissue over the surface of the wound led to complete epithelization of the wound surface after 10-12 days. Since at this time more marked regeneration of the intestinal graft was observed, most epithelization of the connective tissue took place on account of the intestinal epithelium. This was confirmed by the presence of prismatic cells with high alkaline phosphatase activity and of goblet cells in the epithelium covering the wound surface (Fig. 1).

Proliferation of the crypt epithelium at the border of the former defect, its invagination into the underlying connective tissue, and its differentiation into prismatic brush-border epithelium led to the formation of short, irregularly arranged and badly oriented villi and crypts, with the characteristic localization of mucopolysaccharides, nucleic acids, and alkaline phosphatase activity, 30-40 days after transplantation (Fig. 2). Macroscopically at this time the intestinal graft could be seen to be a little larger than originally. A clear boundary was formed between the intestinal and gastric epithelia.

The active process of healing of the intestinal graft in the gastric mucosa of the fundal part of the stomach observed under these conditions was important evidence of its viability.

The results of histochemical and ultrastructural analysis of the graft 3-6 months later demonstrated its state of active function (Fig. 3a). The high alkaline phosphatase activity and the increased content of neutral and acid mucopolysaccharides [1] were important evidence of the normal functioning of the mucous membrane of the intestinal graft.

A study of the state of the intestinal graft after 10-14 months revealed the presence of secondary atrophic changes, evidently due to a disturbance of the course of physiological regeneration (disturbances of the stages of proliferation, differentiation, and rejection), which led to changes in the functional activity of the highly differentiated prismatic and goblet cells (Fig. 3b).

The shortening of the villi, widening of the crypts, and the presence of large numbers of microorganisms in their lumen, some of which penetrated into the cytoplasm of the goblet cells at the moment of extrusion, and the decrease in differentiation of the brush-border cells of the villi were evidence of exhaustion developing as a result of the overstrain and prolonged adaptation of the intestinal graft to its unusual conditions – to a stay in an environment with increased acidity.

However, despite the phenomena of secondary atrophy, no evidence of metaplasia of the intestinal epithelium into gastric, whether in the course of reparative regeneration or during healing and prolonged functioning of the intestinal graft, could be observed.

LITERATURE CITED

1. L. I. Aruin, The Pathomorphology of the Stomach and Small Intestine in Postresection Syndromes, Doctoral Dissertation, Moscow (1971).
2. P. V. Dunaev and A. M. Zhelnina, in: Morphogenesis and Regeneration [in Russian], Tyumen' (1970), p. 165.
3. K. A. Zufarov and É. M. Baibekova, Regeneration of the Gastric Mucous Membrane after Whole-Body Gamma-Ray Irradiation [in Russian], Tashkent (1969).
4. K. A. Zufarov and É. M. Baibekova, in: Proceedings of a Conference to Celebrate the Centenary of the Department of Histology of the S. M. Kirov Military Medical Academy [in Russian], Leningrad (1968), p. 92.
5. V. A. Samsonov, in: Problems in Histotopography and the Special Pathology of the Stomach [in Russian], Petrozavodsk (1971), p. 35.
6. N. C. Klin, M. H. Sleisinger, and E. Weser, Gastroenterology, 52, 1137 (1967).
7. R. Lev, Lab. Invest., 14, 2080 (1965).