EFFECT OF VAGOTOMY ON ULTRASTRUCTURAL ORGANIZATION OF THE ENTEROCHROMAFFIN CELLS OF THE RAT DUODENAL MUCOSA

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An electron-microscopic study was made of the enterochromaffin cells (ECC) of the duodenal mucosa of rats 7, 14, 28, and 56 days after bilateral subdiaphragmatic vagotomy. The results indicate that vagotomy leads to considerable changes in the ultrastructural organization of the ECC, resulting in disturbance of the secretion of 5-hydroxytryptamine (serotonin). The process described is fluctuating in character. The changes reach a maximum on the 7th and 56th days after the operation, with a temporary return almost to the initial level after 28 days.

KEY WORDS: vagotomy; enterochromaffin cells.

In the last decade the local endocrine apparatus of the mucosa of the gastrointestinal tract, consisting of cells known previously as enterochromaffin (ECC), has been a subject for research. Histochemical and electron-microscopic investigations have led endocrine cells of different types to be identified in this cell group. The cells described are distributed diffusely among the enterocytes of the mucous membrane of the small intestine and different types of cells predominate in different parts. ECC are the most widespread type of endocrine cells in the duodenum. Investigations of ECC in diseases of the gastrointestinal tract have not been numerous. No studies of the cells of this group at the ultrastructural level after disturbance of the innervation of the organ could be found in the literature. Meanwhile analysis of the state of the ECC under such conditions is of considerable interest for it can shed light on the response not only of the organ itself, but also of the digestive system as a whole.

With these considerations in mind it was decided to study the effect of vagotomy on the ultrastructural organization of ECC in the mucosa of the rat duodenum.

EXPERIMENTAL METHOD

Experiments were carried out on 12 male albino rats weighing 140 g. Bilateral subdiaphragmatic vagotomy was performed on the animals. Material was taken 7, 14, 28, and 56 days after the operation. Pieces of duodenum measuring 1 × 1 mm were prefixed in 2.5% glutaraldehyde, fixed in Millonig's mixture, dehydrated, and embedded in Araldite. Sections were cut on the LKB ultratome and stained with lead nitrate and uranyl acetate by Reynolds' method. The grids were examined in the HUllE electron microscope. Material from three animals was investigated at each time. Grids from three blocks were examined from one animal.

EXPERIMENTAL RESULTS

Analysis of the state of the ECC 7 days after vagotomy showed massive edema of the secretory granules and disappearance of their normal polymorphism. They acquired a uniform oval shape and were greatly increased in size. Their contents were heterogeneous and with low electron density; a tendency of the granules to combine into large vacuoles, occupying practically the whole cytoplasm, was characteristic, and as a result it was impossible to analyze the state of the intracellular organelles. The nucleus as a rule had uneven outlines and the perinuclear space was a little widened (Figs. 1 and 2). At the same time, cells with features of com-

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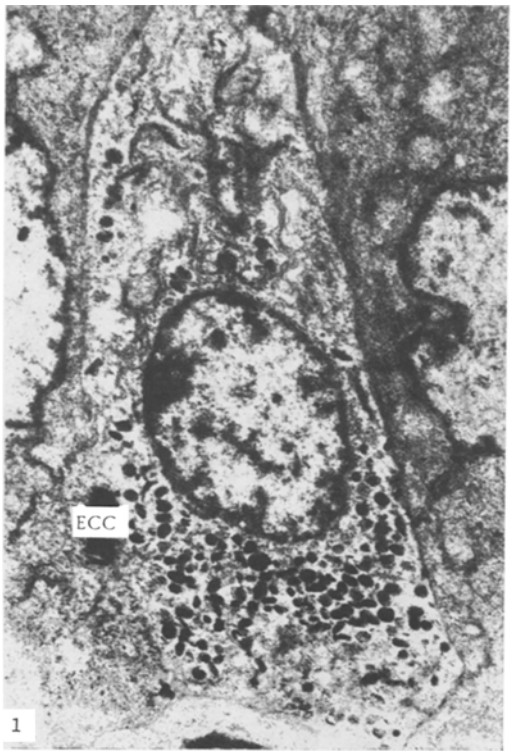

Fig. 1

Fig. 2

Fig. 1. ECC of rat duodenal mucosa. Control (5300 ×).

Fig. 2. ECC of rat duodenal mucosa, 7 days after vagotomy (7400 ×).

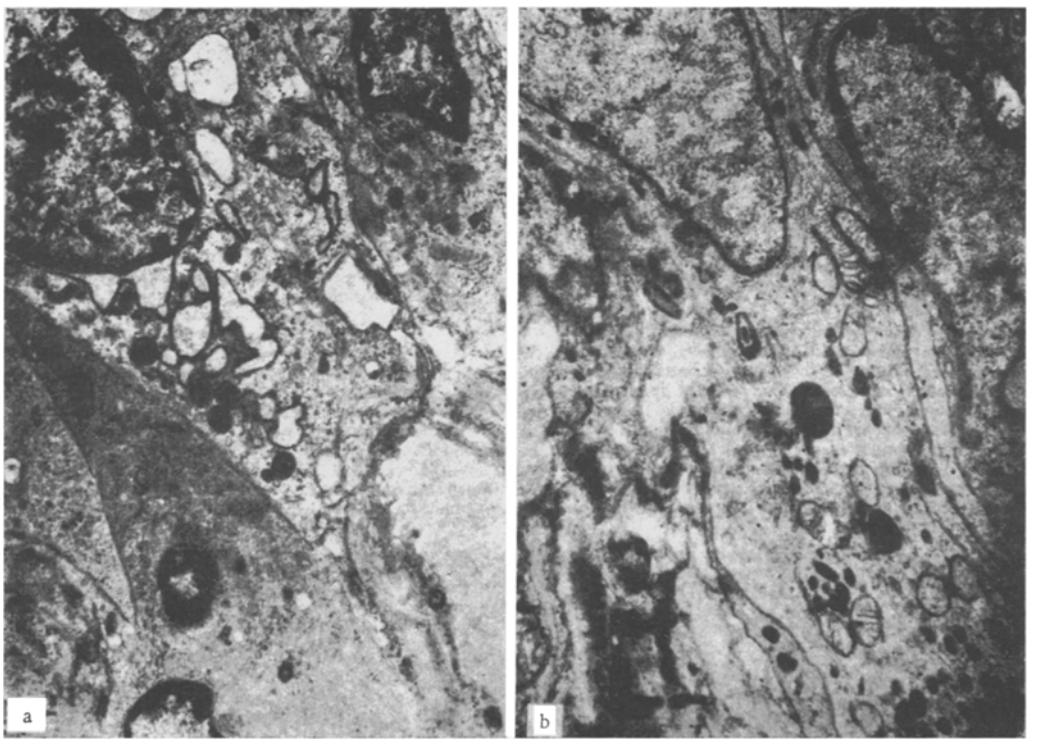

Fig. 3. ECC of rat duodenal mucosa, 14 days after operation: a) widening of perinuclear space and tubules of endoplasmic reticulum (6300 ×) ; b) polymorphism of secretory granules; dimensions and electron density of contents of many of them are close to normal (8000 ×).

plete destruction as well as unchanged cells could be seen.

After 14 days the secretory granules now showed some degree of polymorphism and the dimensions and electron density of the contents of many of them were close to normal. The mitochondria were edematous, local elearings were observed in the matrix, and the cristae were smoothed. The tubules of the endoplasmic reticulum and the perinuclear space were considerably widened (Fig. 3). ECC with dark cytoplasm could be seen.

After 28 days most of the ECC were in the stage of accumulating the secretory product. The shape and size of the granules were normal. The mitochondria were mainly large, with densely packed cristae and with a dark matrix. The tubules of the endoplasmic reticulum and of the Golgi complex were moderately dilated, and the latter contained a substance with low electron density. Numerous free ribosomes appeared in the cytoplasm.

After 56 days edema of the secretory granules of the ECC was again observed but it was less marked than 7 days after the operation. Meanwhile many small mitochondria with a dark matrix appeared. The tubules of the endoplasmic reticulum were widened. The Golgi complex was in an inactive state. The nuclei of some ECC had deep invaginations and the perinuclear space was widened.

The results are evidence that vagotomy leads to considerable changes in the ultrastructural organization of the ECC, with a resulting disturbance of serotonin secretion. This phenomenon is not specific for ECC of the rat duodenum. It is evidently the typical response of the gland cell to an inappropriate situation. Similar changes have been observed in the acinar cells of the parotid gland of rats after removal of the superior cervical sympathetic ganglion [3], in the pancreas of cats after removal of the ganglia of the solar plexus [2], and in rats after subdiaphragmatic vagotomy [1]. The process is fluctuating in character. The changes reach a maximum on the 7th and 56th days after vagotomy, returning almost to their initial level after 28 days.

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