FUNCTIONAL CONNECTIONS OF THE SUBMAXILLARY SALIVARY GLANDS, BASAL PORTIONS OF THE INTESTINAL CRYPTS, AND PANCREATIC ENDOCRINE TISSUE

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The effect of starvation, glucose loading, and administration of the diabetogenic agent dithizone on the state of cells of the pancreatic islets, submaxillary glands, and basal portions of the intestinal crypts was studied in rabbits by the dithizone histochemical reaction. The experimental results point to a possible functional connection between these cells in the mechanism of endocrine regulation of carbohydrate metabolism.

KEY WORDS: dithizone reaction; islets of Langerhans; submaxillary glands; Paneth's cells; starvation; glucose loading; diabetes.

The comparative study described below was carried out because of increasing interest in the study of enteroinsular interrelations [2, 3, 5-7]. The dithizone histochemical reaction was studied in cells of the pancreatic islets, submaxillary salivary glands, and small intestine of rabbits under various experimental conditions modifying the functional state of the insular apparatus. This reaction, as was shown previously, is a sensitive indicator of the functional state of the cells [1, 4].

METHODS

Experiments were carried out on 24 rabbits divided into four main groups: intact, starved for 48 h, receiving 40% glucose solution by intravenous injection in a dose of 10 g/kg, and rabbits with severe diabetes induced by intravenous injection of 50 mg/kg dithizone [4]. The blood sugar was determined by the Hagedorn—Jensen method before the experiment, at the end of the period of starvation, 2 h after injection of glucose, and 1-5 days after injection of dithizone. The animals were killed immediately after the blood samples had been taken. Pieces of pancreas, submaxillary glands, and the distal portion of the ileum were fixed in 70° alcohol saturated with hydrogen sulfide (fixation by Timm's method), and stained with dithizone as described previously [1, 4].

RESULTS

Mild hypoglycemia was observed in the fasting rabbits, and hyperglycemia in rabbits receiving glucose and the diabetic animals. The blood sugar of the latter group usually exceeded 400 mg%.

Purplish-red granules, giving orange-red luminescence in a dark field, were seen in the cytoplasm of cells in preparations stained with dithizone.

Granules were found in the A and B cells of the islets of Langerhans in the pancreas (Fig. 1). The granules were smaller and filled the cytoplasm more uniformly in the glucagon-producing cells of the islets, whereas the granules in the insulin-producing cells were concentrated mainly in the apical regions of the cytoplasm on the side facing the sinusoids.

A positive reaction was found in the submaxillary glands in the cells of the small ducts Whereas in the former granules were found mainly in the basal regions, in the latter they were more numerous in the apical regions of the cytoplasm. In the small intestine dithizone granules were observed in the apical regions of the cells of the basal portions of the intestinal crypts (in Paneth's cells).

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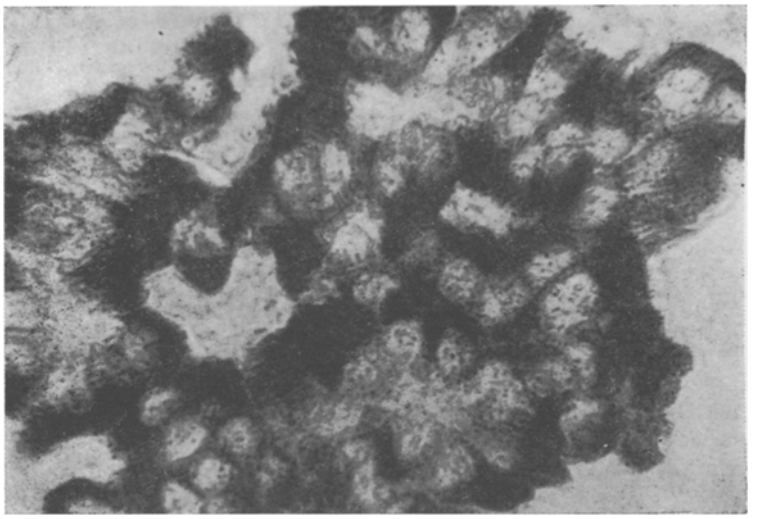

Fig. 1. Dithizone histochemical reaction in cells of pancreatic islets of a rabbit. Zinc granules concentrated mainly in apical parts of cytoplasm of cells arranged around sinusoids. Fixation by Timm's method, 900 ×.

In the starving animals an increase in the number of granules was observed in the B cells of the pancreatic islets and the reaction also was a little stronger in the submaxillary gland. The number of granules was rather smaller in the A cells of the islets of Langerhans and in Paneth's cells.

After glucose loading the reaction of the B cells of the islets and cells of the submaxillary glands was weaker, whereas in the A cells of the islets and in Paneth's cells the number of granules was slightly increased.

In the rabbits with diabetes the dithizone reaction was weaker in all cells, especially in the insulin-producing cells of the islets. The more severe the diabetes, the more marked the changes in the organs studied.

The similarity of the changes suggest a functional link between the A cells of the islets of Langerhans and Paneth's cells of the small intestine, on the one hand, and the B cells of the islets and cells of the submaxillary glands on the other hand.

There are reports in the literature that an insulin-like substance is produced by cells of the submaxillary glands [2] and it is suggested that a glucagon-like substance is produced by Paneth's cells [7].

On the basis of our own observations and data in the literature the existence of a unitary mechanism of regulation, including the organs studied in this investigation, can be postulated. Further research in this direction could yield promising results.

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