

HYPERGLYCEMIC SYNDROME IN DOGS AFTER LOSS OF SECRETIONS OF THE CHIEF DIGESTIVE GLANDS

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Disturbance of the periodic motor and secretory activity of the gastrointestinal tract after loss of the secretions of the digestive glands is accompanied by hyperglycemia, lowering of the glucose tolerance, the development of insulin resistance, an increase in the blood protein level, dysproteinemia, an increase in the concentrations of electrolytes and corticosteroids in the blood plasma, and degenerative changes in the insular system of the pancreas.

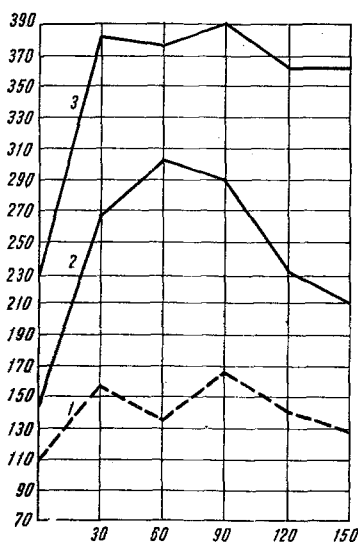


Fig. 1. Blood-sugar curves after administration of a double sugar load to dogs under normal conditions and after loss of a mixture of duodenal secretions for 24 h and 48 h. Abscissa, time of taking blood samples after glucose loading (in min); ordinate, blood sugar concentration (in mg%).

Previous investigations have shown that temporary loss of the mixture of duodenal secretions from fasting animals is accompanied by disturbance of the periodic motor and secretory activity of the digestive organs, disturbance of their bioelectrical activity, by changes in the protein and enzyme composition of the blood, and changes in reflex activity of the brain [1, 2, 4-6, 7-9].

Administration of sugar to such animals gives rise to dyspnea, convulsions, and sometimes to death [8].

The need has therefore arisen for a study of the changes in glucose tolerance of animals after loss of their duodenal secretion.

EXPERIMENTAL METHOD

Experiments were carried out on 11 dogs with metallic fistulae into the stomach and duodenum. To remove secretions from the intestine, fistulas were formed 1-2 cm distally to the point of entry of the pancreatic duct. In four animals, terminal portions of the duodenum (30-35 cm) were isolated below the fistulas by the Hermann-Pavlov or Thiry-Vella methods. In addition, in one animal the duodenum was divided between the bile duct and pancreatic duct. The efferent ends of the duodenum were closed by sutures, and the afferent end was connected to the jejunum. To obtain pancreatic juice alone and a mixture of the secretions of the initial segment of the duodenum, metallic fistulas were formed opposite the bile duct and pancreatic duct.

Periodic activity of the gastro-intestinal tract was studied by a balloon-graphic method. The output of secretions was recorded in millimeters at 10-min intervals. In basic experiments

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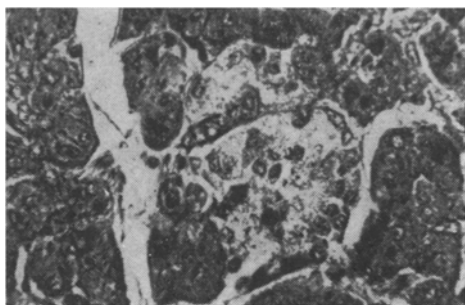


Fig. 2. Insular system of dog's pancreas after repeated loss of mixture of duodenal secretions: hydropic degeneration of α - and β -cells with sharp decrease in number of β -cells. Forsgren's method, 600 \times .

and after loss of a mixture of saliva and gastric juice, pancreatic secretion or a mixture of duodenal juices for 24, 48, and 72 h the blood sugar was determined [3] in a fasting state, after a double glucose load (1.85 g/kg), and also after injection of insulin (0.3 unit/kg) and adrenalin (0.0005 mg/kg body weight). The concentrations of Na and K in the plasma were determined by flame photometry; 11-hydroxycorticosteroids were estimated fluorometrically. In seven dogs, after repeated loss of a mixture of duodenal juices, survey histological studies were made of the stomach, duodenum, liver, pancreas, and adrenals.

EXPERIMENTAL RESULTS

Removal of a mixture of duodenal secretions from the intestine for 12 h and more disturbed periodic motor and secretory activity at the digestive organs: low-amplitude contractions of the smooth muscle and continuous production of small volumes of a mixture of duodenal juices appeared. Under these

conditions the fasting blood sugar rose to 150–210 mg%; the total protein in the blood also increased (to 12%), dysproteinemia developed, and the concentrations of electrolytes and 11-hydroxycorticosteroids in the plasma increased. The longer the animals lost their secretions, the more marked these changes became. Prolonged fasting of the animals without loss of secretions did not give rise to changes such as these. Double loading of the animals with sugar by intravenous or enteral administration of 40% glucose solution after loss of duodenal secretions led to considerable changes in the configuration of the blood-sugar curves. This took the form of a sharp elevation of the blood-sugar curves with the appearance of a negative Staub-Traugott effect, indicating insulin insufficiency. Similar changes in the blood-sugar curves were observed in animals after the repeated loss of a mixture of duodenal juices, and also in dogs during the first few months after isolation of the terminal segment of the duodenum.

If the loss of secretions lasted for more than 24 h, the blood-sugar curves became "diabetic" in character (Fig. 1). In animals with isolated segments of the proximal division of the small intestine, changes in the blood-sugar curves after loss of secretions were more marked.

The insulin test against the background of developing hyperglycemia revealed insulin resistance, which was intensified as the duration of loss of secretions was lengthened. The adrenalin test revealed increased glycogenolysis. The high diabetogenic activity of 11-hydroxycorticosteroids [10] evidently led to loss of the dogs' normal resistance to steroid diabetes. The appearance of hyperglycemia was evidently due not only to disturbance of the utilization of carbohydrates, but also to the excessive formation of glucose from noncarbohydrate sources.

To assess the role of individual secretions in the genesis of these disturbances, experiments were carried out with loss of pancreatic secretion and of a mixture of saliva and gastric juice separately. These showed that loss of any of these secretions produced disturbances, uniform in direction although varied in degree, in the alimentary tract and also in protein, carbohydrate, and electrolyte metabolism.

In dogs which had repeatedly lost a mixture of secretions of the digestive glands, morphological changes were found in the stomach, intestine, and liver. Hydropic degeneration was found in the insular system of the pancreas, with a low content of β -cells and predominance of α -cells, (Fig. 2). Hyperplasia of the zona glomerulosa of the cortex was found in the adrenals.

The results of these experiments demonstrate the important role of secretions of the digestive glands in the hormonal regulation of the digestive organs and the internal medium of the body.

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