CHANGES IN VOLUMES OF BODY FLUIDS IN RATS WITH EXPERIMENTAL PANCREATITIS

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In rats with experimental pancreatitis the volume of intracellular fluid falls during the first 3 h and rises on the 7th-8th day. The water content in the muscles is unchanged in both cases.

Previous investigations [4] on dogs loosing pancreatic juice for long periods and affected with chronic recurrent pancreatitis [1, 5] revealed disturbances of water and salt balance. The main disturbance found was a change in the ratio between the volumes of aqueous phases in the intracellular and extracellular medium, largely as a result of corresponding changes in the volume of extracellular water. An increase or decrease in the volume of extracellular fluid can give rise to corresponding changes in the plasma volume [3].

The next question for study was whether these disturbances are due to a loss of pancreatic juice or to changes in the function of the pancreas itself. To shed light on this problem the present investigation was undertaken. Its object was to study water and mineral metabolism in animals with disturbances of pancreatic function but not losing pancreatic juice.

EXPERIMENTAL METHOD

Experiments were carried out on female rats weighing 140-190 g. Variations in the volume of extracellular water in the rats were estimated from the dilution of inulin, excretion of which was prevented by removal of the kidneys [2]. The serum inulin concentration was determined by the resorcin method [7]. To assess changes in the water content in the tissues, pieces were cut from the same group of femoral muscles and weighed samples were dried to constant weight. The concentrations of sodium, potassium, and calcium in the serum were determined by flame photometry.

In each experiment the batch of rats were divided into two groups, experimental and control. Pancreatitis was produced in the experimental rats by injecting 0.1-0.2 ml pancreatic juice from dogs into the parenchyma of the gland. The rats of the control group underwent the same procedures (laparotomy, general anesthesia) as the experimental animals except for the injection of pancreatic juice into the gland. Distribution of the aqueous phases in the body of the experimental and control rats was investigated at the same time during the 3 h, or on the 7th-8th day, after the disturbance of pancreatic function.

At the end of the experiment the state of the pancreas was assessed visually in all the rats. In addition, in 10 experimental rats (5 in the acute phase and 5 on the 7th day of the disease), the pancreas was investigated histologically (fixation by Bouin's method). Paraffin sections were stained with hematoxylin-eosin and with azan by Gomori's method.

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EXPERIMENTAL RESULTS AND DISCUSSION

The distribution of the aqueous phases in the rats with experimental pancreatitis was disturbed very rapidly: within a few hours after injection of juice into the pancreas the mean volume of extracellular fluid in the experimental rats was 120 ± 2 ml/kg, and in the controls 144 ± 7 ml/kg ($P < 0.001$). Since the kidneys had been removed from all these animals, the decrease in volume of extracellular fluid could not have resulted from its excretion in the urine, but it was evidently the result of a redistribution of water in the body. So far as the water content in the muscles is concerned, this was the same in the control and experimental animals. This suggests that the volume of extracellular fluid was reduced by its displacement into the tissue cells. The serum concentrations of potassium, calcium, and sodium were the same in the experimental and control rats.

The volume of extracellular fluid was increased on the 7th-8th day after disturbance of pancreatic function: 160 ± 4 ml/kg body weight in the experimental rats and 135 ± 5 ml/kg in the controls ($P < 0.001$). The water content in the muscles of the experimental and control rats was the same. At these times, just as during the first few hours after injection of juice into the pancreas, the change in volume of extracellular fluid was probably due to redistribution of water between the extracellular medium and the cells.

The pancreas of the rats in which experimental pancreatitis was produced was firm and nodular after 3 h. Its vessels were dilated, and in some places there were hemorrhages. On the 7th-8th day adhesions were formed between the pancreas and neighboring organs (stomach, spleen, intestine). The pancreas was spotted, firm, and reduced in size. Plaques of steatonecrosis were visible on the pancreas and mesentery. Microscopic investigations showed that 3 h after injection of the juice severe inflammation had developed, accompanied by a serous effusion, separating the acini, and infiltration of the affected area with leukocytes. On the 7th-8th day after injection of juice into the pancreas, connective tissue began to form. The pathological changes in the pancreas of these animals were identical with those described in the literature [6].

Hence, in rats with experimental pancreatitis, just as in dogs losing pancreatic juice over long periods, disturbances of the distribution of the aqueous phases in the body arise. These facts suggest that the pancreas is functionally linked with the mechanisms regulating water and salt balance. Disturbance of pancreatic function produces changes in the ratio between the volumes of intracellular and extracellular fluids. This redistribution of water may lead to changes in the plasma volume, to disturbance of the circulation, and to dehydration even without any substantial change in the total water content in the body [8].

LITERATURE CITED

1. G. N. Voronin and Z. S. Lavrova, in: Mechanisms of Nervous and Humoral Regulation of Physiological Processes [in Russian], (1966), p. 31.
2. Yu. I. Ivanov and B. A. Pakhmurnyi, Byull. Éksperim. Biol. i Med., No. 4, 123 (1965).
3. Z. S. Lavrova, in: The Physiology of Digestion [in Russian], Part 1, Odessa (1967), p. 176.
4. Z. S. Lavrova, Fiziol. Zh. SSSR, No. 9, 1136 (1969).
5. A. V. Rikkl', in: Interaction between Organs of the Digestive System [in Russian], Leningrad (1968), p. 110.
6. T. Arai, Proc. Soc. Exp. Biol. (New York), 119, 1120 (1965).
7. Y. E. Schreiner, Proc. Soc. Exp. Biol. (New York), 74, 117 (1950).
8. Sogabe Hitoshi, Yokohama Med. Bull., 13, 386 (1962).