MORPHOLOGY AND PATHOMORPHOLOGY

MORPHOLOGIC CHANGES IN THE PANCREAS IN HEMORRHAGIC SHOCK AND IN THE POSTRESUSCITATION PERIOD

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Recent investigations have ascribed an important role to the pancreas in the pathogenesis of shock [1, 3]. It is very sensitive to ischemia, and in shock the blood flow in it is sharply reduced [5, 6, 8, 9]. Pancreatic ischemia increases the serum cathepsin D activity by 27 times [9]. In experimental hemorrhagic shock a tenfold increase in trypsin activity has been found in the arterial blood of dogs, whereas in depancreatized animals, levels of trypsin activity were unchanged. The fact that the proteolytic activity of the blood is increased in shock and other extremal situations can be taken as established, but problems to do with the identification of the enzymes appearing in the blood and their source still remain matters for debate. Some workers [7] consider that the sources of proteases are the lysosomal enzymes released on death of the cells, whereas others [2, 6] associate the increased proteolytic activity with enzymes secreted by the pancreas.

The aim of this investigation was a morphological study of the pancreatic acinar tissue after acute massive blood loss and at different stages of the postresuscitation period.

EXPERIMENTAL METHOD

Experiments were carried out on adult mongrel dogs (20) of both sexes weighing 10-12 kg. Experiments on the animals were done under superficial pentobarbital anesthesia with trimeperidine premedication, and with the use of local procaine anesthesia during dissection and catheterization of the carotid and femoral arteries. There were two series of experiments. In series I (five dogs) a terminal state (clinical death lasting 3 min) was simulated, by a single massive bleeding from the femoral artery. In series II (15 dogs), after blood loss and the terminal state, the animals were resuscitated by the use of a combination of measures (intraarterial injection of the animal's own blood, artificial ventilation of the lungs, indirect cardiac massage and, if necessary, defibrillation). For the morphological investigation biopsy specimens of the pancreas were taken from anesthetized animals in the terminal state and 1, 24, and 48 h after resuscitation. Material for histological investigation was fixed in neutral formalin and embedded in paraffin wax; sections were stained with hematoxylin and eosin and by Mallory's method. Pancreatic tissue for electron-microscopic investigation was fixed in 2.5% glutaraldehyde solution, postfixed in 1% OsO4 solution, and embedded in Araldite. The sections were stained with methylene blue and azure, and ultrathin sections with lead nitrate, and examined in the ЕВМ-100B electron microscope. The serum enzyme profile of the animals was determined at the same time, with determination of α-amylase activity by the method in [5] and of trypsin activity by Erlanger's method in the modification in [4].

EXPERIMENTAL RESULTS

After acute blood loss, the pancreas preserved its lobular structure histologically. Arteries in spasm and dilated, congested veins could be seen in the edematous connective tissue of the interlobular spaces. Secretory ducts of all calibers, free from secretion, were clearly outlined. The cytoplasm of the acinar cells (AC) was characterized by increased basophilia and by narrowing of the zone of eosinophilia. Secretory granules in the cytoplasm of AC in sections stained by Mallory's method and in semithin sections could not be identified (Fig. 1a).
Fig. 1. Changes in pancreas associated with acute blood loss. a) Accumulation of secretion in lumen of centroacinar ducts (CAD), absence of ZG in cytoplasm of AC. Semithin section. Methylene blue and azure. 900x; b) accumulation of immature zymogen granules (IZG), of low electron density, in cytoplasm of AC. 14,000x; c) Interrupted outlines of membranes of ZG with formation of micropores (arrow). 38,000x; d) Macro- and micropinocytotic vesicles in cytoplasm of a papillary endotheliocyte (EC). 32,000x.

Ultrastructural study of the apical zones of the cytoplasm of AC revealed numerous immature zymogen granules (ZG) of low electron density. Numerous micropores were found in the membranes of the granules (Fig. 1b, c). The apical plasmalemma of AC had numerous microvilli. The ZG did not make contact with membranes of the central acinar ducts, and no signs of extrusion of secretion were present. The location, shape, and structure of the mitochondria were unchanged. The narrow lumen of the interacinar capillaries was filled with plasma. The number of micro- and macropinocytotic vesicles in the cytoplasm of the endotheliocytes was increased (Fig. 1d).

At the height of hemorrhagic shock an increase in the α-amylase and trypsin titers was observed in the blood serum of the animals (Table 1), evidence of incretion of the secreted enzymes into the blood stream.

Acute blood loss is thus accompanied by changes in the blood supply to the pancreas, manifested as anemia in the arterial system and capillary bed and congestion of vessels of the venous collector. Structural changes in endotheliocytes of the capillaries and venules indicate increased vascular permeability, mainly for plasm.

A study of the pancreocytes of the pancreas revealed reduced electron density of ZG, evidence of reduction of the protein fractions and of their composition. The discovery of defects in the membranes of ZG and the formation of micropores may be evidence of "leakage" of the protein component from the granules.