CHANGES IN THE ACETYLCHOLINE – CHOLINESTERASE SYSTEM IN DOGS DURING FASTING PERIODIC ACTIVITY OF THE DIGESTIVE TRACT

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In fasting dogs considerable fluctuations occur in the acetylcholine concentration and cholinesterase activity in the blood of the portal vein, depending on the phase of the fasting periodic activity of the intestine. An increase in the acetylcholine concentration in the blood in the contraction phase coincides with lowering of the serum pseudocholinesterase activity, acetylcholinesterase activity of the erythrocytes in the blood, and tissue cholinesterase activity of the erythrocytes in the blood, and tissue cholinesterase activity in the intestine.

Depending on the phase of fasting periodic activity, definite biochemical and physical changes take place in the body [4].

There is no information in the literature on the acetylcholine (AC) concentration and cholinesterase (CE) activity in the blood draining from the intestine during the various phases of its periodic function, and the CE activity in the intestinal wall itself has not been investigated. Only CE activity and the AC concentration in the circulating blood during fasting periodic activity of the stomach in intact dogs and in dogs with an Eck–Pavlov fistula have been determined in Speranskaya's laboratory [1, 2, 8, 9].

The object of the present investigation was to study the dynamics of the CA concentration and pseudocholinesterase (PCE) activity of the serum, acetylcholinesterase activity in the erythrocytes from blood in the portal system, and tissue CE activity in the small intestine in the various stages of its periodic activity.

EXPERIMENTAL METHOD

Acute experiments were carried out on 21 adult dogs. The experiment began 18–20 h after the animals were fed. Laparotomy was performed under general anesthesia, and a loop of the proximal portion of the small intestine was exteriorized. A purse-string suture was applied, and in the center of it the lumen of the intestine was opened, and a small rubber balloon (volume 2–3 ml) was inserted into it and connected with a Marey's capsule to record the contraction on a smoked kymograph drum. At the same time, a hollow needle was introduced into the portal vein. The needle was connected to a vinyl chloride tube, the other end of which was brought outside when the abdominal wall was closed. To prevent the blood from clotting, the lumen of the tube was filled with physiological saline containing heparin, and closed with a stopper. At the beginning of the period of rest or work, samples of blood were taken for analysis. Intestinal tissue was removed for investigation at the end of the experiment during one of the phases of periodic intestinal activity. CE activity was determined by Hestrin's method [13], and the AC concentration by a biological method on the isolated frog lung by Corsten's method [12] in Khamitov's modification [11].

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EXPERIMENTAL RESULTS

The results of these experiments showed that during periodic activity of the gastro-intestinal tract the acetylcholine–cholinesterase (AC–CE) system undergoes considerable changes. The AC concentration in blood obtained from the portal vein in the period of intestinal contraction averaged 18.16 ± 1.1 μg/ml, compared with 1.7± 0.1 μg/ml in the resting period. The PCE activity in the plasma was considerably lower during the period of active contraction than in the period of relative rest (4.74 ± 0.6 and 8.74 ± 0.9 mg/ml per h, respectively). The CE activity also fell sharply in the period of work in the erythrocytes (3.51 ± 0.29 and 6.45 ± 0.38 mg/ml per h, respectively) and in the intestinal wall (4.93 ± 0.73 and 9.68 ± 0.69 mg/g per h, respectively).

Since the periodic activity of all the divisions of the gastro-intestinal tract is not synchronized, i.e., periods of contraction and periods of rest may take place simultaneously in different portions [5], biologically active agents stimulating smooth muscles were always found to some degree in the portal venous system. The period of movements of the proximal portion of the small intestine coincides with a period of work of the esophagus, stomach, and duodenum [3, 7]. The simultaneous active movement of these portions of the gastro-intestinal tract is evidently accompanied by the liberation of larger quantities of AC and other biologically active substances into the blood of the portal system than during the period of work of the distal portion of the digestive apparatus, which takes place when the small intestine, together with all the more proximal part of the gastro-intestinal tract, is in the period of rest.

The presence of AC in the circulating blood only during work [9] is probably attributable to the fact that the appearance of large quantities of acetylcholine-like substances in the portal venous system at a time of increased activity of the gastro-intestinal tract leads to partial failure of the hepatic barrier [10] and, as a result of this, to the appearance of AC in the peripheral circulation. The AC concentration in the period of rest in the portal venous system is much lower, and its residual part after contact with CE is completely destroyed in the liver, so that at this period it naturally cannot be detected in the peripheral circulation. The leading role in AC hydrolysis is played by its enzyme CE, and the hepatic barrier in this respect must be regarded as an additional regulator in the AC–CE system.

It can be concluded from these investigations that with excitation of cholinergic nerves the AC–CE system undergoes substantial changes. With the onset of the period of work, large quantities of AC appear in the portal venous system, but its concentration falls in the period of rest. In response to an increase in the quantity of parasympathetic mediator, CE activity rises and reaches a maximum in the period of rest. Low CE activity in the period of work compared with the period of rest is evidently explained by its substrate inhibition [6], arising in the presence of an excess of AC resulting from excitation of the cholinergic system.

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