CHANGES IN THE CATECHOLAMINE LEVEL IN NORADRENALIN-SYNTHESIZING BRAIN STRUCTURES OF RATS AFTER IMMOBILIZATION

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The locus coeruleus (LC) and nucleus subcoeruleus (NSC) are the largest concentrations of noradrenalin-synthesizing neurons in the brain. There is much evidence of the extensive and virtually universal nature of the connections of LC neurons, whose axons spread monosynaptically with their branches to cells of the cerebral cortex, cerebellum, and many nuclei of the diencephalon, brain stem, and spinal cord. Neurons of NSC give rise mainly to a periventricular plexus in the hypothalamus and preoptic region [3]. The predominant localization of terminal ramifications of axons of NSC in the hypothalamus and of LC in the cerebral cortex provided the basis for the suggestion that there are functional differences between these various nuclei. It is claimed that LC is connected with the coordination of cortical activity, whereas NSC is mainly associated with the regulation of neuroendocrine functions. The concrete functional relations between LC and NSC are unknown.

To study the role of the noradrenalin-synthesizing brain nuclei in the organization of emotional stress, the catecholamine (CA) concentration was determined separately in LC and NSC after immobilization of animals.

EXPERIMENTAL METHOD

Wistar rats weighing 300-350 g were immobilized for 6.5 h with strict fixation of the limbs and head. The arterial pressure (BP) was measured immediately before immobilization and every hour during its course by the direct method, with a catheter inserted into the caudal artery [2]. After decapitation, the state of the gastric mucosa was determined under the low power of the microscope. Depending on the response of BP the experimental animals were divided into three groups: 1) rats (Nos. 1, 4, 7, 10, 20) whose BP during immobilization was increased by 20 mm Hg or more; 2) animals (Nos. 2, 6, 8, 13, 16, 19) whose BP during immobilization exhibited the greatest stability (BP rose by not more than 15 mm Hg); 3) animals (Nos. 9, 14, 18) whose BP fell abruptly during immobilization. The wall of the stomach after immobilization for 6.5 h was damaged in all the rats. In rats Nos. 1, 9, 14, 18, 19, and 20, which constituted group I, hemorrhages were observed in the gastric mucosa; in rats Nos. 2, 4, 6, 7, 8, 10, 13, and 18, constituting group II, the stomach wall was ulcerated. Six male rats of the same body weight as the experimental animals served as the control. LC and NSC were taken by the method recommended by Palkovits [4] from frontal brain sections 300 μm thick. The CA level in LC and NSC was determined by a highly sensitive radioenzyme method [5, 6].

EXPERIMENTAL RESULTS

The adrenalin content in LC increased by 41% when BP rose (group 1) but decreased by 45% when BP fell (group 3) compared with the control (Fig. 1). Comparison of groups I and II and also individual comparisons showed that the state of the stomach wall was not reflected in the adrenalin concentration in LC. For example, rats Nos. 4 and 10 displayed the most

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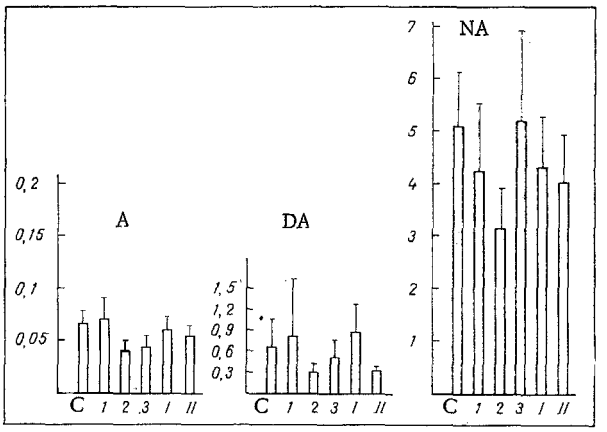

Fig. 1

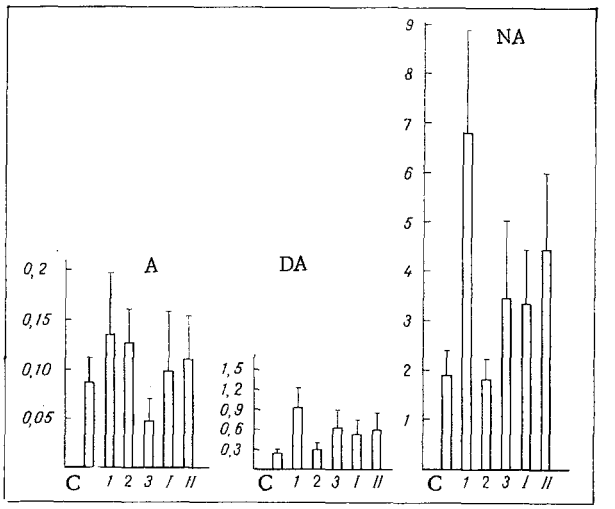

Fig. 2

Fig. 1. Changes in CA level in LC after immobilization for 6.5 h of animals grouped together on the basis of responses of BP and character of lesion in gastric mucosa. Abscissa) groups of animals; ordinate) catecholamine concentration (in pg/μg protein). A) Adrenalin; NA) nonradrenalin; DA) dopamine; C) control. Mean values and standard errors shown. Significance calculated by t test. a) Differences between control and experiment significant ($P < 0.05$), b) differences between groups 1 and 2 significant ($P < 0.05$).

Fig. 2. Changes in CA level in NSC after immobilization for 6.5 h of animals grouped together on the basis of responses of BP and character of lesion in gastric mucosa. Legend as to Fig. 1.

severe and similar ulceration of the stomach wall (5 ulcers with a total length of 33.5 mm and 5 ulcers with a total length of 26.5 mm respectively), but the adrenalin concentration differed in these rats by an order of magnitude (0.170 and 0.018 pg/μg respectively. In rats Nos. 8 and 10 the adrenalin level was virtually the same, and the changes in BP were similar in type; as regards the state of their stomach wall, however, these rats differed sharply (in rat No. 8 there was one ulcer 4.5 mm long).

The noradrenalin concentration was highest in the rats of group 1, i.e., in animals responding to immobilization by an increase in BP. Individual variations within the group were large. The highest noradrenalin level was found in rats Nos. 5 and 7 (10.482 and 12.646 pg/μg respectively), which were distinguished by a similar type of change in BP, although the degree of ulceration of the stomach wall differed in rats Nos. 4 and 7 (the total length of the ulcers was 33.5 and 9 mm respectively).

Changes in the dopamine level in the experimental animals were similar to changes in the noradrenalin concentration, but the differences between groups of animals distinguished by the behavior of their BP were more marked. Just as with the determination of noradrenalin, the highest dopamine level was observed in rats (Nos. 4 and 7) whose BP was raised most sharply during immobilization (1.879 and 1.231 pg/μg respectively). A less sharp rise in the dopamine content (not statistically significant) was found in animals whose BP fell during immobilization (group 3). In the animals of group 2 (with the most stable BP) the dopamine level was practically indistinguishable from that in the control. Individual variability of the dopamine level in the animals of group 3 was in the same direction as in the group as a whole, i.e., considerable deviations of BP (a fall in the case of rats of group 3) coincided with a high dopamine level (and also noradrenalin). For example, in rats Nos. 14 and 18, whose BP fell sharply, the dopamine concentration was 1.004 and 0.718 pg/μg respectively. In rat No. 9, whose BP rose toward the end of the experiment up to the control level, the dopamine concentration was significantly lower than in the other two rats of this group (0.206 pg/μg).

No correlation was found between changes in CA and the state of the stomach wall when groups I and II or the individual data were compared.

Correlation was thus observed between changes in the CA level in LC and the state of BP

during immobilization. It can be tentatively suggested that the specific nature of changes in the cardiovascular functions during emotional stress is largely connected with the character of functioning of LC neurons. The results of the present investigation confirm earlier views on the homeostatic function of LC [1].

By contrast with LC, no correlation was found in NSC between changes in the CA level and the response of BP and of the gastric mucosa (Fig. 2). Consequently, two noradrenalin-synthesizing brain formations, in close proximity to one another, play an essentially different role in the organization of the emotional stress reaction.

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"SHOCK LUNG" AND BLOOD RHEOLOGY IN EXPERIMENTAL PANCREATITIS

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The syndrome of acute pulmonary disturbances ("shock lung") is one of the most serious complications of pancreatic necrosis and it develops against a background of marked disturbances of both the systemic and the pulmonary circulation [7]. An important role in the pathogenesis of the syndrome is played by changes in the rheologic properties of the blood arising during progression of pancreatogenic shock [3, 7]. The aim of the present investigation was to study the hemorheologic disorders and their effect on development of the syndrome of acute pulmonary disturbances in pancreatic necrosis.

EXPERIMENTAL METHOD

Altogether 22 experiments were carried out on mongrel dogs weighing 18-22 kg. Pancreatic necrosis was induced by the method of Anderson et al. [1]. Under intravenous thiopental anesthesia (20 mg/kg), after premedication with trimeperidine (5 mg/kg), the cranial vena cava, pulmonary artery, and thoracic aorta were catheterized. For the pulmonary artery a Swan–Ganz triple-barreled balloon catheter was used; the position of the catheter was verified by monitoring the intracardiac pressure curve on an oscilloscope.

The pressure in the orifice of the venae cavae (CVP), in the pulmonary artery (P_{mean}), and in the thoracic aorta (AP_{mean}) was recorded on a Mingograph-82 apparatus (from Siemens). The circulating blood volume (CBV) and cardiac output (CO) were determined by a radiocardiographic method with [^{131}I]albumin. The gas composition of the arterial (P_aO_2) and mixed venous blood was determined by the micro-Astrup method on a Radelkis apparatus (Hungary) and the oxygen saturation of hemoglobin was measured on an Oximeter apparatus (Denmark). The pulmonary shunt Q_s/Q_t was determined after hyperoxygenation for 20 min in accordance with Berrgren's equation and with the aid of the nomogram of Stadler et al. [6]. To estimate the rheologic properties of the blood, the structural viscosity of mixed venous blood (η_0), the

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