UNEQUAL SENSITIVITY OF THE ARTERIAL SYSTEMS OF THE BRAIN TO NORADRENALIN

R. S. Mirzoyan

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An investigation on unanesthetized and anesthetized cats showed that noradrenalin acts directly on the brain vessels and increases their tone. Noradrenalin was also found to affect blood vessels of the different arterial systems of the brain unequally: It raised the perfusion pressure in the system of the carotid arteries more than in the vertebral arterial system.

KEY WORDS: pharamacology of the cerebral circulation; noradrenalin.

The sensitivity of the brain vessels to noradrenalin (NA) has not been finally settled. According to some workers, NA reduces the circulation in brain tissue by increasing the tone of the intracranial vessels [1-3, 9, 10]. Others consider that the action of NA on the cerebral vessels is not direct [8, 11, 12], but indirect through changes in the pH of the CSF [7, 13].

The object of this investigation was to study the effect of NA on the circulation in the various arterial systems of the brain.

EXPERIMENTAL METHOD

Experiments were carried out on 34 cats weighing 3-4 kg. The cerebral blood flow was determined in unanesthetized animals after preliminary implantation of the sensitive element of an electromagnetic blood flow meter. This element, with a lumen 1 mm in diameter, was applied to the common carotid artery and all branches supplying the extracerebral tissues of the head with blood were tied at a point along its course where the blood moving along the artery entered the brain via the internal maxillary artery. An electromagnetic meter also recorded the flow of blood into the brain in cats anesthetized with urethane (0.5 g/kg) and chloralose (50 mg/kg) during artificial ventilation of the lungs. The volume velocity of the intracranial blood flow also was determined with the aid of Xe^{133} on the VaV-100 apparatus, using the Minsk-22 computer to process the data [6]. The vascular components of the action of NA on the cerebral hemodynamics was differentiated by separate bilateral perfusions of the carotid and vertebral arteries [4]. Indices of the acid–base balance and partial pressure of oxygen were determined in samples of arterial blood and CSF by means of the ABC-1 apparatus.

EXPERIMENTAL RESULTS AND DISCUSSION

After intravenous injection of 0.15-0.2 μg/kg NA into unanesthetized cats the intracranial blood flow was reduced to some degree (by 12% on average), whereas the arterial pressure rose (Fig. 1, 1). These results indicate the ability of NA to increase the tone of the cerebral vessels. However, to rule out the possible role of self-regulatory mechanisms or changes in the respiratory functions under the influence of NA, its action was studied on the cerebral circulation in anesthetized animals with stabilized respiration. In these experiments NA was injected into the internal maxillary artery and the intracranial blood flow was determined with the aid of Xe^{133} and an electromagnetic flow meter. Considering that in this series of experiments the animals were anesthetized, a larger dose of the drug was given (1 μg/kg). NA, injected intra-

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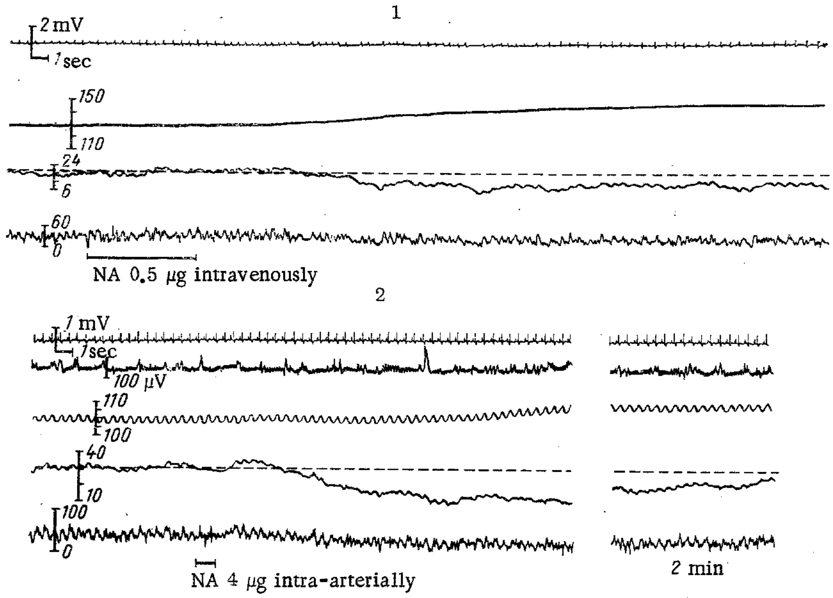

Fig. 1. Effect of NA on intracranial blood flow in cats in chronic (1) and acute (2) experiments. From top to bottom: ECG in lead II; EEG from parietal region (in acute experiment), arterial pressure (in mm Hg), averaged and phasic blood flow in internal maxillary artery (in ml/min), marker of noradrenalin injection.

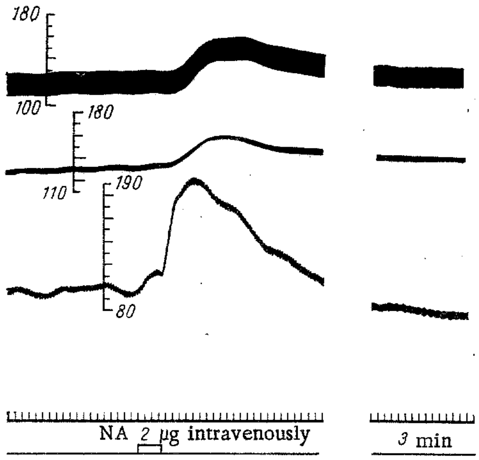

Fig. 2. Effect of NA (2 mg intravenously) on tone of vessels in carotid and vertebral arterial systems of the brain. From top to bottom: perfusion pressure in internal maxillary arteries; resistogram of vertebral arteries; arterial pressure; time marker 5 sec; marker of injection of drug.

arterially, led to a considerable (by 45 ± 3% on average) decrease in the volume velocity of the intracranial blood flow (Fig. 1, 2). The decrease in the blood supply to the brain preceded changes in the blood pressure, indicating that NA can act directly on intracranial vessels. This conclusion was confirmed by experiments in which the method of resistography was used. When injected intravenously in doses of 0.5-3 μg/kg, NA caused a marked increase in tone of the cerebral vessels. The experiments also showed that the carotid arterial system is more sensitive to noradrenalin than the vertebral system. Under the influence of NA the increase in perfusion pressure in the carotid arterial system was 35 ± 5.2%, whereas the tone of the vessels in the vertebral arterial system was increased by 20 ± 3.2% ($P < 0.05$) (Fig. 2). This agrees completely with the observed effect of electrical stimulation of the cervical sympathetic trunks on the cerebral circulation [5]. Consequently, the vessels of the carotid system are more sensitive to sympathetic influences than the arteries of the vertebral system.

No changes in pH, pCO_2, pO_2, or the percentage of oxyhemoglobin could be found in samples of arterial blood taken from the anesthetized animals 1 and 10 min after intravenous injection of noradrenalin in the maximal dose (3 μg/kg). NA likewise did not change pH, pCO_2, or pO_2 of the CSF.

NA thus has a marked effect on the cerebral vessels, increasing their tone in both anesthetized and unanesthetized animals. The absence of any change in pCO_2 in the arterial blood or in pH of the CSF in this case suggests that constriction of the lumen of the intracranial vessels is due to the ability of NA to excite cerebrovascular adrenergic structures.

Differences in the sensitivity of the different arterial systems of the brain to NA can be considered to be due to the unequal distribution of α-adrenergic structures in the brain vessels and their role is connected with functional differences between those parts of the CNS that are supplied with blood from the systems of the carotid and vertebral arteries.

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