DIFFERENCES IN CEREBROVASCULAR EFFECTS OF PHENOXYBENZAMINE

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UDC 615.217.24.015.4:612.824

Phenoxybenzamine differs in its effects on the blood supply in different vascular regions of the brain. It increases the blood supply in the vertebral arterial system whereas in the territory of the carotid arteries the blood flow is reduced. Meanwhile, phenoxybenzamine has a marked depriming effect on nervous regulation of the cerebral circualtion. It depresses reflex responses of the intracranial vessels, reduces the changes in the cerebral blood flow induced by stimulation of the cervical sympathetic nerves, and has a protective effect after experimental disturbance of the cerebral circulation.

KEY WORDS: cerebral circulation; nervous regulation of the cerebral circulation; α-adrenoblockers.

The role of the sympathetic innervation and, in particular, of the α-adrenergic structures of the intracranial vessels in the regulation of the intracranial circulation has not been finally elucidated [1, 7, 9, 12]. It is stated in the literature that phenoxybenzamine has no significant effect on the cerebral circulation or on the oxygen consumption of the brain [11]. Meanwhile, phenoxybenzamine has been shown to prevent the development of spasms of the intracranial vessels during neurosurgical operations [6], hypocapnia [8], and subarachnoid hemorrhages [10].

The object of this investigation was to analyze the effect of phenoxybenzamine on the blood supply to the brain.

EXPERIMENTAL METHOD

Experiments were carried out on 42 cats weighing 3-4 kg anesthetized with urethane (0.5 g/kg) under artificial ventillation conditions. The cerebral blood flow was determined with the aid of radioactive xenon (Xe^{133}) on the VAV-100 apparatus. The results were analyzed by the Minsk-22 computer. The cerebral blood flow was determined by successive derivation of indicator functions [2, 5]. The state of the cerebral circulation also was judged from the inflow of blood into the brain of the cats through the internal maxillary artery as recorded with an electromagnetic blood flow meter. In a separate series of experiments the blood flow in the vertebral artery was determined by the same method. For this purpose the detector of the meter was placed on the subclavian artery before the origin of its vertebral branch, and the distal portion of the subclavian artery was ligated. The EEG was recorded simultaneously in the parietal region, the ECG in lead II, and the blood pressure in the femoral artery.

The vascular component of action of the drug on the cerebral hemodynamics was differentiated by separate bilateral perfusion of the carotid and vertebral arteries [3].

Indices of the acid–base balance and partial oxygen pressure were determined in samples of arterial blood and cerebrospinal fluid by means of the ABC-1 apparatus.

Phenoxybenzamine was used in doses of 0.5-1 mg/kg.

Laboratory of Pharmacology of the Cardiovascular System, Institute of Pharmacology, Academy of Medical Sciences of the USSR, Moscow. (Presented by Academician of the Academy of Medical Sciences of the USSR V. V. Zakusov.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 79, No. 6, pp. 60-63, June, 1975. Original article submitted July 12, 1974.

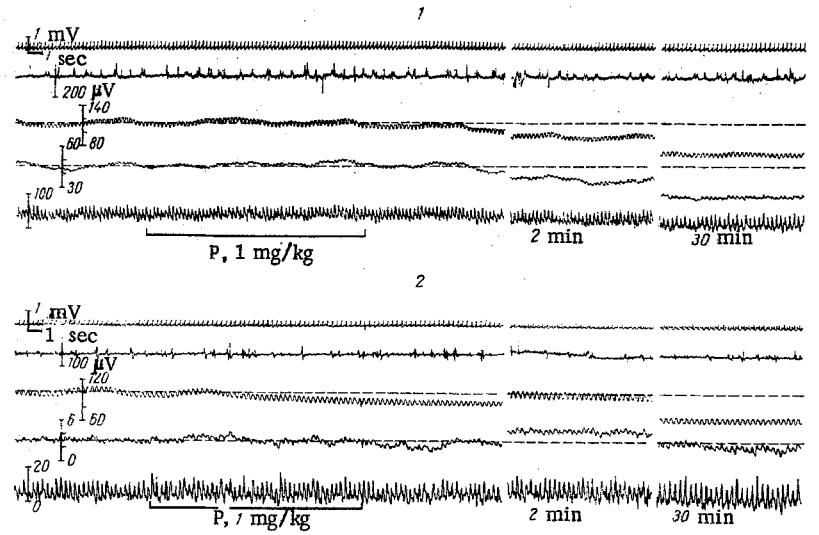

Fig. 1. Changes in blood flow in internal maxillary (1) and vertebral (2) arteries of cats under the influence of phenoxybenzamine (P). From top to bottom: ECG in lead II, EEG from parietal region, arterial pressure (in mm Hg), averaged and phasic blood flow (in ml/min), marker of injection of drug.

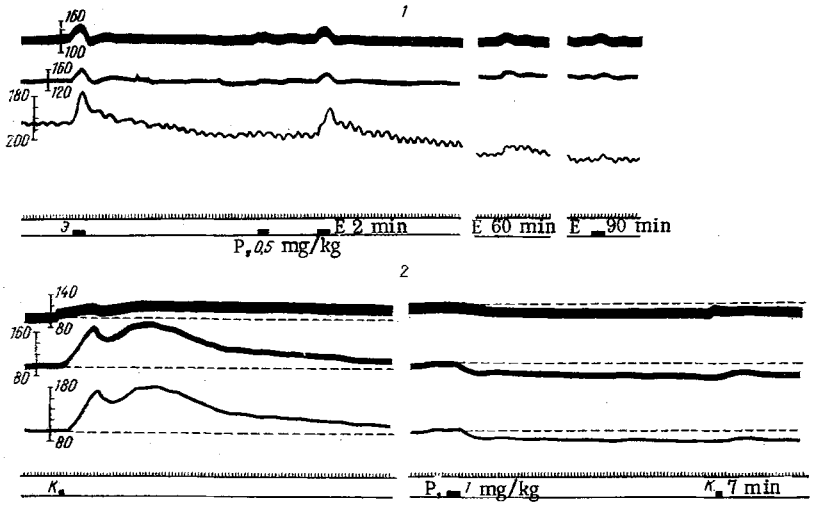

Fig. 2. Effect of phenoxybenzamine (P) on responses of cerebral vessels to electrical stimulation (E) of tibial nerve (1) and to injection of potassium chloride (K) into lateral ventricle of cat brain (2). From top to bottom: perfusion pressure in internal maxillary arteries; resistogram of vertebral arteries; time marker, 5 sec; marker of electrical stimulation and injection of substances.

EXPERIMENTAL RESULTS AND DISCUSSION

Experiments with Xe^{133} showed that phenoxybenzamine, in a dose of 1 mg/kg, reduces the cerebral blood flow on the average by 24%. Similar results were obtained in experiments with electromagnetic recording of the blood flow into the brain through the internal maxillary artery. However, in some cases a very slight (4-10%) and brief (5-20 sec) increase in the intracranial blood flow took place during the first 10-20 sec after injection of phenoxybenzamine, followed by a decrease. The volume velocity of the cerebral blood flow did not return to its initial level before the end of the experiments (Fig. 1, 1).

The study of the effect of phenoxybenzamine on the tone of the intracranial arteries by separate bilateral perfusion showed that the resistance to the blood flow in the territory of the carotid arteries fell by

9 ± 1.4%, whereas in the cerebral system it fell by 21 ± 4% (Fig. 2, 2). This difference is statistically significant ($P < 0.02$). It thus appeared most probable that the drug increased the circulation in the vertebral arterial system. To clarify this problem a special series of experiments was carried out in which the effect of phenoxybenzamine was studied on the blood flow into the brain through the vertebral arteries. They showed that under the influence of phenoxybenzamine (1 mg/kg) the blood flow in the vertebral arteries increased by 47 ± 5.5% (Fig. 1, 2). The increase in the cerebral circulation took place immediately after injection. Phenoxybenzamine caused no significant changes in the EEG and ECG.

Later the effect of the drug was investigated on reflex responses of the intracranial vessels to electrical stimulation of the tibial nerve (10-40 V, 20-40 stimuli/sec, 1 msec). These experiments showed that phenoxybenzamine (0.5-1 mg/kg, intravenously) almost completely blocked the reflex responses in both arterial systems of the brain (Fig. 2, 1). Electrical stimulation of the cervical sympathetic nerve led to a decrease of 51 ± 3.1% in the volume velocity of the intracranial blood flow. Phenoxybenzamine considerably inhibited this response of the cerebral vessels.

The effects of phenoxybenzamine also were studied after experimental disturbance of the intracranial circulation of neurogenic nature (injection of potassium chloride [4]). These experiments showed that phenoxybenzamine (0.5-1 mg/kg), injected 7-120 min before potassium chloride, leads to very slight changes compared with the control in the tone of the cerebral vessels and the arterial pressure (Fig. 2, 2).

No change in pH, pCO_2, pO_2, or the percentage of oxyhemoglobin was found in samples of arterial blood taken before and also 1 and 40 min after injection of phenoxybenzamine. Phenoxybenzamine likewise did not change the hydrogen ion concentration or the partial pressure of oxygen and carbon dioxide in the cerebrospinal fluid.

Phenoxybenzamine thus differed in its effect in the different vascular regions of the brain. It caused an increase in the circulation in the vertebral arterial system but a decrease in the system of the carotid arteries. This difference was evidently not connected with the peripheral α-adrenoblocking properties of phenoxybenzamine, for the preparation affects nervous regulation of the carotid and vertebral arterial systems of the brain equally. Moreover, other α-adrenoblockers (tropaphen,* dihydroergotoxin) have no selective action on the tone of the intracranial vessels.

Phenoxybenzamine also has a marked depriming effect on nervous regulation of the cerebral circulation. It considerably inhibits reflex responses of the intracranial vessels and changes in the cerebral blood flow caused by stimulation of the cervical sympathetic nerves. It has a protective effect in experimental disturbance of the cerebral circulation caused by potassium chloride. These effects, on the other hand, are due to its ability to block α-adrenergic structures of the intracranial vessels.

On the basis of these results phenoxybenzamine can be recommended in clinical neurology and neurosurgery for the treatment of cerebrovascular diseases affecting primarily the vertebro-basilar arterial system.

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*Tropine ester of β-acetoxyphenyl-α-phenylpropionic acid – Translator.