type. In this case the AAN in which the GPEE is created plays the role of determinant structure in the genesis of the pathological system, for which the vagus centers constitute the intermediate stage.

LITERATURE CITED

1. E. A. Andrikyan and O. D. Gaske, Fiziol. Zh. SSSR, No. 1, 13 (1967).
2. A. D. Becheka and A. F. Koseko, in: Problems in the Physiology of the Hypothalamus (Interinstitute Scientific Reports) [in Russian], No. 11, Kiev (1977), p. 61.
3. M. Ya. Buryak, in: Current Problems in the Pharmacology of the Reticular Formation and Synaptic Transmission [in Russian], Leningrad (1963), p. 266.
4. G. N. Kryzhanovskii, Determinant Structures in the Pathology of the Nervous System [in Russian], Moscow (1980).
5. A. A. Ul'yaninskii, E. I. Stepanyan, É. I. Agapova, et al., Kardiologiya, No. 4, 94 (1978).
6. L. S. Ul'yaninskii, A. I. Balashov, A. V. Grishak, et al., Byull. Eksp. Biol. Med., No. 12, 1288 (1979).
7. B. M. Fedorov, The Mechanisms of Disturbance and Recovery of Cardiac Activity [in Russian], Moscow (1968).
8. B. M. Fedorov, Fiziol. Zh. SSSR, No. 6, 948 (1974).
9. B. M. Fedorov, Emotions and Cardiac Activity [in Russian], Moscow (1977).
10. F. R. Calaresu, A. Faiers, and G. Mogenson, Prog. Neurobiol., 5, 1 (1975).
11. F. R. Calaresu and M. Thomas, Brain Res., 2-3, 235 (1975).
12. D. R. Curtis, C. J. A. Game, and G. A. R. Johnston, Brain Res., 43, 242 (1972).
13. R. A. Davidoff, Brain Res., 45, 638 (1972).
14. J. F. R. Koning and R. A. Klippel, The Rat Brain, Baltimore (1963).
15. D. J. Reis and M. C. Oliphant, J. Neurophysiol., 27, 893 (1964).
16. N. M. Van Gelder, J. Neurochem., 16, 1355 (1969).

TIME COURSE OF THE LOCAL CORTICAL BLOOD FLOW IN EXPERIMENTAL CEREBRAL ISCHEMIA

L. N. Dorokhova, V. A. Sorokoumov, and V. A. Tsyrlin

UDC 616.831-005.4-092.
9-07:616.831-005-031.85-07

KEY WORDS: cerebral ischemia; local cortical blood flow; arterial pressure.

Local cerebral ischemia is accompanied not only by disturbances of the local cerebral circulation, but also by considerable hemodynamic changes at a distance from the ischemized focus [1-6]. However, the time course of the blood flow in different parts of the brain after local ischemia still remains virtually unstudied. The investigation described below accordingly was carried out to study changes in the cerebral blood flow in different parts of the cortex and some mechanisms of its regulation at different times after the formation of a focus of cerebral ischemia.

EXPERIMENTAL METHOD

Experiments were carried out on 98 cats of both sexes weighing 2.5-4 kg. The animals were prepared for the experiments under general halothane anesthesia. To create an ischemic

---

Department of Pharmacology, Central Research Laboratory, and Department of Nervous Diseases, I. P. Pavlov First Leningrad Medical Institute. Department of Experimental Cardiology, Leningrad Research Institute of Cardiology.

(Presented by Academician of the Academy of Medical Sciences of the USSR N. P. Bekhtereva.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 93, No. 5, pp. 29-32, May, 1982. Original article submitted July 15, 1981.

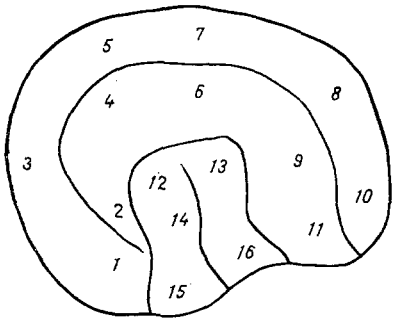
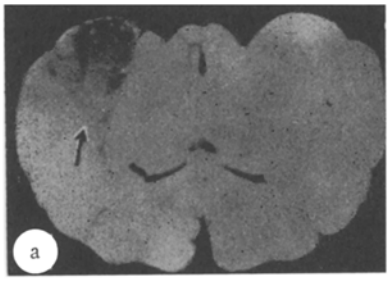


Fig. 1. Location of zones of recording local cerebral blood flow. Explanation in text.



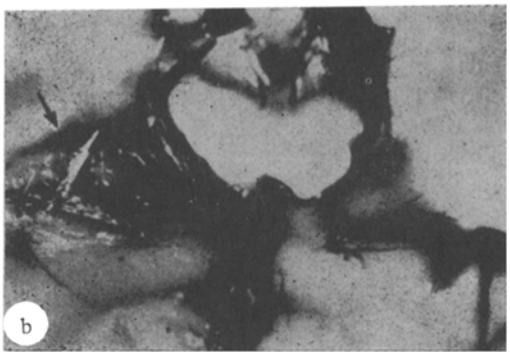


Fig. 2. Location of ischemic focus after compression of middle cerebral artery. a) Clip on middle cerebral artery (arrow), b) transverse section through brain with zone of necrosis (arrow).

focus, an area of bone 0.5 cm in diameter was resected in 80 animals from the right temporal bone at the level of the wing of the sphenoid bone and a metal clip was applied to the trunk of the middle cerebral artery (between the 2nd and 3rd efferent branches, counting from the base of the artery). In 29 experiments the operative preparation ceased at this stage and the wound was sutured in layers. In 69 cases (when the artery was not compressed or when the cerebral blood flow was recorded during the first few hours after creation of the ischemic focus) multiple burr-holes 1 mm in diameter were drilled in the right side of the skull for subsequent insertion of platinum electrodes, 200 μ in diameter, and recording of the local cortical blood flow (LCBF) in the zones indicated in Fig. 1. One burr-hole was made in the left temporal zone above the cortical zone designated No. 2 (Fig. 1). The femoral artery and vein were catheterized. A second operation was performed on some animals with an ischemic focus, 2 days (12 cats) or 14 days (17 cats) after compression of the middle cerebral artery: Burr-holes were drilled, platinum electrodes were inserted, and the blood vessels were catheterized. The LCBF was recorded by the hydrogen clearance method (hydrogen was injected into the animal's trachae during one inspiration) 1 h after the end of the preparatory operation. The cerebral blood flow was determined by means of two LP-17 polarographs. During the experiment the animals were immobilized with listhenon (2 mg/kg after 10-15 min) and artificially ventilated. To raise the arterial pressure artifically, phenylephrine was given in doses of 0.01-0.3 mg/kg. The arterial pressure was raised in steps and the hypertension was maintained for 8-10 min. After the experiment 100 ml of ink was injected through the right

TABLE 1. Time Course of Blood Flow in Different Zones of Cerebral Cortex at Different Times after Formation of Ischemic Focus

Experimental conditions	Arterial pressure	Cerebral blood flow, ml/min/100 g tissue															
		left hemisphere	right hemisphere														
			Zone of recording of blood flow														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Control	118±3,8	138±3	136±2	133±4	128±4	121±3	96±2	126±2	100±5	92±3	128±2	100±6	72±5	78±5	74±3	68±3	72±2	76±2
After occlusion of cerebral artery	109±1,7	122±3	100±3	64±2	83±2	87±1	75±3	50±2	26±3	53±2	94±2	110±6	26±3	0	0	0	0	0
(n=51)																		
48 h	99±3	48±5	187±9	89±3	75±2	56±2	16±4	32±2	26±4	47±2	82±2	96±3	55±2	30±6	0	0	0	0
(n=12)																		
14 days	109±3	63±2	138±3	121±2	128±2	121±2	94±2	130±2	103±3	78±1	130±2	111±5	65±2	65±2	72±2	0	0	0
(n = 17)																		

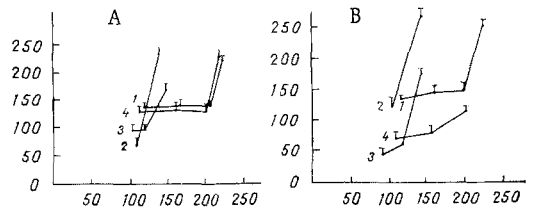


Fig. 3. Character of autoregulation of cerebral blood flow in right (A) and left (B) hemispheres. Abscissa, arterial pressure (in mm Hg); ordinate, cerebral blood flow (in ml/min/100 g tissue). 1) Animals with intact cerebral circulation, 2) 1-1.5 h after compression of middle cerebral artery, 3) 2 days after creation of ischemic focus 4) 14 days after ischemization.

carotid artery into the animals with occlusion of the middle cerebral artery. The brain was removed from the skull and placed in 5% formalin solution. The zone of cerebral ischemia was identified in histological sections (Fig. 2).

EXPERIMENTAL RESULTS

Character of the LCBF in Cats with an Intact Cerebral Circulation. The LCBF was measured 60-80 min after the end of the operation at 16 points, each located in the zones indicated in Fig. 1. Even though the location of the stimulating electrode within the brain zones varied in different animals by as much as 0.5-5 mm, the values of LCBF were sufficiently close in the same zone in different cats (Table 1). As Table 1 shows, the values of LCBF in the gray matter of the cortex varied from 67 to 136 ml/min/100 g tissue.

In all cases the ability of the cerebral blood vessels to maintain a constant blood flow in the presence of artificial hypertension was studied in zone No. 2 (Fig. 1) on both sides. Raising the blood pressure to 180-190 mm Hg caused no significant change in LCBF, and an increase in the blood flow was produced only by hypertension above 200 mm Hg (Fig. 3).

Nature of LCBF Among Cats with Ischemic Insults. Within $1^1/_2$-2 h after occlusion of the medial cranial artery next to zones of complete cessation of circulation we noticed that regions of the brain showed decreased circulation. As the table indicates, on the left side of the cerebral cortex (LCBF was measured in zone No. 2, see Fig. 1) a tendency towards decrease in LCBF was also expressed. Within 48 h after ischemic insults, left-handed paresis of the forepaw was clearly apparent in the animals (in certain cases the cats experienced no paralysis of the limbs, but others experienced significant deterioration of muscular strength). We noted the LCBF dynamics in various zones of the right cerebral cortex: In addition to its rise in certain zones, we observed a drop in others. As the same time, a significant drop in LCBF in the experimental region of the left hemisphere was observed (see Table 1).

No paresis of the limbs was observed 14 days after occlusion of the middle cerebral artery. The blood flow in different zones of the right hemisphere was almost completely restored, but in the left "intact" hemisphere in the region of measurement the blood flow was reduced by half compared with the control (Table 1), although without any signs of disturbance of function.

It will be clear from Fig. 3 that the formation of an ischemic focus not only reduced the LCBF, but also disturbed autoregulation of the cerebral blood flow (in all experiments autoregulation was studied in zone No. 2 on both sides). In the acute period of ischemization a very small increase in the systemic arterial pressure led to an increase in LCBF in both right and the left hemispheres. Autoregulation was restored in both hemispheres 14 days after creation of the ischemic focus, although the initial values of LCBF differed significantly (Table 1).

The investigations thus showed that local cerebral ischemia leads to marked changes in the local blood flow in different zones of the cerebral cortex. Disturbances of the mechanisms of regulation of the cerebral circulation are observed under these circumstances not only on the side of the lesion of the cerebral vessels, but also in the hemisphere with an intact blood supply.

LITERATURE CITED

1. K. Nakai, K. M. A. Welch, and J. S. Meyer, J. Neurol. Neurosurg. Psychiat., 40, 595 (1977).
2. J. Olesen, Acta Neurol. Scand., Suppl. No. 57, 50 (1974).
3. O. Paulson, Stroke, 4, 327 (1971).
4. T. M. Sundt and A. G. Waltz, Proc. Mayo Clin., 41, 159 (1966).
5. Z. Symon, J. Neurol. Neurosurg. Psychiat., 33, 756 (1970).
6. A. G. Waltz and T. M. Sundt, Brain, 90, 681 (1967).

PROTECTIVE ROLE OF THE HYPOTHALAMUS AGAINST PATHOLOGICAL CARDIAC REFLEXES

G. E. Samonina

UDC 616.12-009.81-02:/616.831.31+616.831.41

KEY WORDS: hypothalamus; modulating influences; cardiocardiac reflexes; viscerocardiac reflexes; pathological reflexes; control.

It is well known that the higher levels of the brain exert modulating influences on cardiac reflexes [4, 8, 11-17]. However, the character of these influences has not been explained. Most workers consider that they are entirely inhibitory. The possibility of facilitatory modulating influences on the cardiac component of baroreflexes has received occasional mention in the literature [12-14]. Experiments by the present writer on different classes of vertebrates (bony fishes, amphibians, mammals) showed that in the early stages of phylogenetic development the higher levels of the brain are adapted to exert modulating influences in various directions on the "cardiac parasympathetic center" in the medulla [5-10], where the arcs of these reflexes are closed. These influences may produce both augmentation and inhibition of cardiocardiac reflexes or may even abolish them completely. Both augmentation and weakening of reflexes were found by the writer in response to stimulation of the hypothalamic region in fishes [5] and frogs [2, 5] and of the cerebral cortex in cats [7, 8]. Influences of both types were exhibited on reflexes developing both during and immediately after stimulation of the brain. The character of the modulating influences probably depends on many factors and, in particular, on the degree of activation of higher levels of the brain [6, 8]. The two-way influences of higher levels of the brain, including the cerebral cortex, on cardiac reflexes revealed during electrical stimulation are confirmed also by the results of an investigation of cardiocardiac reflexes before and after surgical decortication [10]. Blocking descending influences from the cortex could be accompanied by both augmentation and weakening of reflexes in cats. This indicates the possibility of dual modulating influences under natural conditions also. Duality of modulating influences from the hypothalamus has been discovered by the writer on viscerocardial reflexes also [2], which must be regarded as one variety of pathological reflexes.

It was accordingly interesting to compare correlation between facilitatory and inhibitory influences from the hypothalamus on adaptive cardiocardiac and pathological viscerocardiac reflexes.

EXPERIMENTAL METHOD

Experiments were carried out on frogs. A small balloon was introduced into the right atrium, and distension of this balloon led to activation of the cardiac receptors and to the onset of cardiocardiac reflexes. Viscerocardiac reflexes were evoked by stretching the urinary bladder [2]. The hypothalamus was stimulated by square pulses of current passed through extracellular metal microelectrodes. The parameters of stimulation used were below

Department of Physiology of Man and Animals, Faculty of Biology, M. V. Lomonosov Moscow University. (Presented by Academician of the Academy of Medical Sciences of the USSR, V. A. Negovskii.) Translated from Byulleten' Éksperimental'noi Biologii Meditsiny, Vol. 93, No. 5, pp. 32-33, May, 1982. Original article submitted February 11, 1981.

