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EFFECT OF ACETYLCHOLINE AND HISTAMINE ON TONUS OF INTRACRANIAL --ETC(U)
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FOREIGN TECHNOLOGY DIVISION

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By

M. D. Gayevyy, S. P. Trofimenko

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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

EFFECT OF ACETYLCHOLINE AND HISTAMINE ON TONUS OF INTRACRANIAL AND EXTRACRANIAL VESSELS, THE VOLUME RATE OF CEREBRAL BLOOD CIRCULATION AND OXYGEN TENSION IN BRAIN TISSUE

M. D. Gayevyy, S. P. Trofimenko

Department of Pharmacology (K. O. Oralbayev, Director), Medical Institute, Semipalatinsk

ABSTRACT The effect of various doses of acetylcholine and histamine on the blood circulation of the brain was studied in acute experiments on 86 anesthetized cats under controlled breathing, using the technique of resistography,

rheoencephalography, and registration of the volumetric rate of cerebral blood flow and oxygen tension in brain tissues by means of the polarographic method.

The results of the experiments show that acetylcholine and histamine with intravenous and intracarotid injection reduce the tonus of the intracranial and extracranial vessels and that the reaction of the latter is more pronounced. The volumetric rate of cerebral blood flow in the case of stabilized arterial pressure increased under the influence of the studied preparations. In the case of unstabilized pressure, blood flow depended to a certain extent on total arterial pressure, which always dropped in the case of intravenous injection of the indicated preparations. Oxygen tension in the brain tissue generally changed parallel to blood flow. END ABSTRACT

A number of published reports [1, 8, 9, 11, 12-14] have been dedicated to the role of acetylcholine in neuroreflector regulation of the tonus of the cranial vessels under standard and pathological states. Some researchers also regard histamine as one factor in the neuroendocrine regulation of vascular tonus. The literature

on this problem is expounded in great detail in the monograph by V. I. Uspenskiy [18]. The author also introduces data on the functional relationship between the mediators of the neural system and histamine.

At the same time we encounter clinical studies, whose authors [15, 30] ascribe great significance to histamine and the development of disturbances in cerebral blood circulation, accompanied by headaches. Consequently, study of the effect of acetylcholine and histamine on the vessels of the brain is not only theoretical, but also a practical problem. However, the effect of these biologically active amines on cerebral blood circulation has not been thoroughly studied, and the results of studies are often contradictory, particularly with respect to the histamine [3, 8, 17, 22, 23, 26], which lead us to the present study. We thought it would be interesting to compare the effect of histamine and acetylcholine on the tonus of the intracranial and extracranial vessels proceeding from the following ideas.

The extracranial vessels of the head have a close relationship to the intracranial, both from the standpoint of anatomy and function. There exists a hypothesis, according to which the amount of blood entering the brain

is controlled by active change in the passage of extracranial vessels [13]. Experimental data [8, 27, 28] indicate that the reaction of the extracranial vessels of the head under the influence of various agents may differ from the reaction of the intracranial vessels both qualitatively and quantitatively. Some authors [29] believe that vascular headaches may arise as the result of overextension of each pulse wave of the external arteries of the head (temples, back of the head).

Technique

Acute experiments were conducted on 86 cats weighing 2-3.5 kg under chloraloso(0.04 g/kg)-urethane (0.6 g/kg) anesthetic.

To speed up the onset of anesthesia and suppress aggressiveness, the animals were first given hexenal intra-abdominally (0.1 g). The reaction of the vessels to the studied substances was studied by the method of resistography, rheoencephalography, and registration of the volumetric rate of cerebral blood flow under conditions of stabilized and unstabilized perfusive blood pressure. In

studying vascular tonus by the method of autoperfusion, it was very important to ligate the vessels in order to eliminate anastomoses between the intracranial and extracranial vascular basins and eliminate collatoral blood supply to the perfused region. For this purpose many authors ([10, 16] and others) in experiments on cats ligate all branches of the outer carotic arteries on both sides, retaining intact only the branches of the intramaxillary arteries, which in cats serve the function of reduced internal carotic arteries. Also ligated is the main artery at the base of the brain. This method of ligation of vessels is more successful in studying the vascular tonus of the brain, and perfusion through both outer carotic arteries under these conditions reflects the change in resistance of the vessels of the brain, with the exception of the medulla oblongata and the back third of the pons varolii.

We use this method of ligating the vessels with certain variations for parallel perfusion of the intracerebral and extracerebral vessels. Thus, on one side all branches of the carotic artery were ligated, leaving intact only the branches of the internal maxillary artery feeding the brain (Fig. 1A). Ligated on the other side was

the external carotic artery past the point where the extracranial branches (myogenic branches, lingual artery, etc.) branch off from it. The vessels were perfused by means of a two-channel resistograph [18]. One channel of the resistograph was connected to a T-joint (Fig. 1A, 4) for perfusion of the intracranial vessels; the other - to the cannula (Fig. 1A, 3) of the extracranial vessels. The common inlet of the perfusion channels was connected to the central ring of one of the common carotic arteries. Generally ligation of the branches of the arteries supplying soft tissues of the head (muscles, skin) involves no difficulty, particularly, for large cats weighing 3-4 kg, in which the vessels are easily prepared. It is more difficult to ligate the main artery at the base of the brain. N. M. Ryzhova offered some very good advice on access to this artery and a more convenient way of selecting a site for its ligation. We are very indebted to her.

It should be mentioned that this operation is rather difficult and traumatic, and we were not always able to find the main artery. Apparently there are cases of its atypical location in cats. Therefore, in some experiments, instead of the main artery, we ligated the vertebral arteries at the place where they enter the same canal. The

fact that such ligation does satisfactorily separate the perfused region from the general arterial bed is well illustrated in Fig. 1B, where we see that when blood ceases to enter the perfused vascular basins, there is a sudden pressure drop in the system of the intracranial vessels of from 96 to 30 mm Hg and from 80 to 14 mm Hg in the system of extracranial arteries. Within approximately 30 seconds we noticed a certain tendency toward increased pressure in the system of intracranial vessels. This indicates that when the access of the blcod to the brain is cut off along the carotic arteries the connection between the carotid basin and the vertebral arteries through the circulus variolii remains intact. When, however, against this background the vertebral arteries were ligated on both sides, pressure in the system of intracranial vessels dropped to 8 mm Hg, i.e., to a level close to zero. We observed a similar pattern in other experiments. These data convincingly demonstrate that ligation of the vertebral arteries is also a fairly reliable method of isolating the perfused region from the general arterial system of the animal. When pressure in the carotic arteries drops, we note a certain increase in total arterial pressure, which can be explained by a reflex from the mechano receptors of the carotid sinuses. When the vertebral arteries were

ligated, a very pronounced increase in arterial pressure also developed. Apparently this reaction is in response to anoxia of the brain centers. The increase in arterial pressure with anoxia of the brain is indicated by other published data [9].

In control experiments it was also established that under the conditions of the ligation of vessels described above, total separation of the perfused vascular (intracranial and extracranial) basins is achieved. Confirmation of this is provided by experiments in which self-hardening plastics (protacryl) of different colors were poured separately into the system of intracranial and extracranial vessels. Here only the appropriate vascular basin was filled. The plastic did not flow from one vascular basin to the other.

In separate series of experiments the volumetric rate of cerebral blood flow was measured by means of a flow meter [4, 5], which was connected by cannulas to the carotic arteries. The inlet of the flow meter was connected to the thoracic end of the general carotic artery, the outlet - through a T-joint to the general outer carotic arteries. Here the appropriate vessels were also ligated by

the method described in [10, 16]. In experiments with stabilization of perfusion pressure a regional arterial pressure stabilizer was attached to the flow meter [7].

Used in addition to the methods of autoperfusion of the cranial vessels in these experiments was rheography of the cranium. Rheoencephalograms were taken of anesthetized animals under controlled breathing with an orbital-occipital lead using rheographic attachment RG1-01, attached to a two-channel electrocardiograph. Registered along with the REG were EKG with a standard II lead. The recording was done at the moment that the artificial respiration apparatus was turned off for a short time (4-5 s) [6].

Oxygen tension in the brain tissues was studied by the polarographic method and registered by means of an oxyhemograph [2]. The cathode was an amalgamated copper electrode, which was inserted to a depth of 2-3 mm into the parietal portion of the cerebral cortex.

Total arterial pressure (in the general carotic or femoral artery) and perfusion pressure (at the output of the perfusion pumps) were registered by a mercury manometer on a chemograph tape. To prevent coagulation of the blood

the animals were administered heparin intravenously.

In all experiments the original values of blood pressure and blood flow were recorded along with the change in them after the preparations had been introduced. Initial data averaged from all observations were compiled for a systemic arterial pressure of 94.7 ± 3 mm Hg; for perfusion pressure in the system of intracranial vessels - 95.4 ± 3.3 mm Hg; for perfusion pressure in the system of extracranial vessels 96.6 ± 4.6 mm Hg; for the volume rate of brain blood flow 18.9 ± 0.7 ml of blood per 1 min. Presented in the text are averaged data in percentage of the initial level, obtained from statistical processing of each series of experiments (period of most pronounced effect compared with original level).

Results of Study

Acetylcholine. In experiments with resistography the intravenous injection of acetylcholine in doses of 2-3 μg/kg (7 experiments) caused a short-term (about 3-minute) reduction in the tonus of the intracranial vessels by 24 ± 4.5% ($p < 0.1\%$) and by 30 ± 2.1% ($p < 0.1\%$) in

the extracranial vessels for about 5 minutes. The effect is most pronounced in the first minute after injection of the preparation. Total arterial pressure dropped by 45 ± 1.8% ($p < 0.1\%$) immediately after the injection of the acetylcholine, and within 4-5 minutes returned to its original level.

Intravenous injection of acetylcholine in doses of 5-6 μg/kg (6 experiments) caused a reduction of 25 ± 0.9% ($p < 0.1\%$) in the tonus of the intracranial vessels and of 27 ± 2.9% ($p < 0.1\%$) in the extracranial. The recovery of tonus to the original level occurred within 5-7 minutes, respectively, after injection of the preparation. Total arterial pressure in this case dropped by 58 ± 4.1% ($p < 0.1\%$), and gradually return to the original level within 10 minutes on the average. Consequently, an increase in the dose of acetylcholine affected primarily the level of total arterial pressure and the duration of the effect.

According to the data of the rheoencephalogram, intravenous injection of acetylcholine in doses of 2-3 μg/kg (6 experiments) caused an increase of 132 ± 36% ($p < 0.1\%$) in the amplitude of the rheographic wave and a drop of 53 ± 4.6% ($p < 0.1\%$) in total arterial

pressure. The effect was apparent immediately after injection of the preparation, and within 3-5 minutes the amplitude of the REG and arterial pressure returned to their original values. Besides the increase in the amplitude of the REG, in certain experiments a sharpening of the peak of the rheographic wave was observed, provided it had been smoothed prior to injection of the preparation, along with a deepening and a downward shift in the dicrotic dip. Such changes in the REG, according to the data of [21], indicate a decrease in the tonus of the vessels in the brain and an increase in their filling. Figure 2(A, B) shows the effect of the acetylcholine on the tonus of the cranial vessels and the total arterial pressure.

In experiments in which the volume rate of blood flow was measured under nonstabilized pressure in the maxillary arteries, the intravenous injection of acetylcholine in doses of 3-5 μg/kg (7 experiments) caused blood flow to decrease by 40 ± 3.9% ($p < 0.1\%$). This decrease in the blood flow occurred immediately after the injection of the preparation and coincided with the more pronounced decrease in total arterial pressure (by 54 ± 4.6%; $p < 0.1\%$). Within 4-6 minutes the blood flow and arterial pressure returned to their original value (Fig. 3A).

Parallel with the decrease in blood flow, oxygen tension in the brain tissues fell by 28 ± 2.5% ($p < 0.1\%$). Consequently, the decrease in total arterial pressure under the influence of the acetylene leads to a decrease in the volume rate of blood flow and oxygen tension in the brain tissues, despite the significant decrease in the tonus of the vessels of the brain under the influence of the preparation.

In the case of stabilized pressure in the carotic arteries intravenous injection of the same doses of acetylcholine (6 experiments) caused blood flow to increase by 28 ± 7.6% ($p = 0.1\%$). This increased blood flow was more pronounced in the first and second minutes after injection of the preparation, and subsequently returned to the original values within an average of 5 minutes. Total arterial pressure in these experiments dropped by 49 ± 2.6% ($p < 0.1\%$) (Fig. 3B). Parallel with the increase in blood flow was an increase in oxygen tension in the brain tissues. The greatest increase in PO_2 occurred in the second minute after injection of the preparation (this was on the average of 16 ± 3.7% ($p = 0.2\%$). Thereafter

PO_2 gradually decreased, and within 8 minutes it had returned to its original values.

Histamine . We note from the resistographic data that intravenous injection of histamine in doses of 10 μg/kg (8 experiments) caused a decrease in the tonus of the intracranial vessels of 20 ± 2.4% ($p < 0.1\%$) and 26 ± 8.3% ($p = 0.9\%$) in the extracranial vessels. The effect developed immediately after injection of the preparation, was most pronounced in the first minute, and continued for an average of 8 minutes. Total arterial pressure after injection of the preparation dropped by 20 ± 2.7% ($p < 0.1\%$), and within 5-6 minutes returned to the original level (Fig. 4A).

According to rheoencephalographic data, histamine in doses of 10 μg/kg (6 experiments) immediately after intravenous injection, caused the amplitude of the rheographic wave to increase by 129 ± 20% ($p < 0.1\%$) on the average (Fig. 4B). Here, in some experiments, a sharpening in the peak of the rheographic wave was noted, if it had been smooth prior to the injection. Also noted was a deepening and downward shift in the presystolic dip, which, according to the data of [21], indicates a pressure

increase in the venous system of the brain and congestion of the venous blood. These changes in the amplitude and shape of the rheographic wave were brief, and within 3-5 minutes after injection of the histamine the original pattern had returned completely. With further observation in the three experiments no changes in the rheographic wave were observed to the end of the experiment (30-40 minutes). In the remaining experiments, after an initial increase in the amplitude of the REG, there developed a gradual decrease in amplitude - 33% on the average - as compared to the original value. This second phase lasted from 5 to 10 minutes.

In studying the volume rate of blood flow in the brain in experiments without pressure stabilization in the carotic arteries, intravenous injection of the histamine in doses of 5 μg/kg (6 experiments) caused a short-term (up to 1 minute) decrease of 27 ± 2.4% ($p < 0.1$) in blood flow immediately after injection of the preparation. This deceleration in the blood flow coincided with the most pronounced drop in total arterial pressure - by 35 ± 6% on the average ($p < 0.1$). By the beginning of the second minute the blood flow rapidly increased, and generally exceeded the original values by 34 ± 11% (p =

3). Arterial pressure during this time returned to its original level, and in some experiments even exceeded it. By the fourth or fifth minute blood flow and arterial pressure differed little from the original values.

In the case of intravenous injection of histamine in doses of 10 μg/kg (6 experiments) the nature of the changes in blood flow and arterial pressure was the same as for doses of 5 μg/kg, except that the effect was more prolonged (Fig. 5A). Under conditions of stabilized pressure in the carotic arteries, intravenous injection of histamine in doses of 5 μg/kg (7 experiments) caused a 45 ± 7.1% ($p < 0.1\%$) increase in blood flow. The effect was felt immediately after the injection of the preparation, was most pronounced for the first and second minutes, and continued for about 5 minutes. Thereafter statistically unreliable deviations in blood flow from the original values were observed. When histamine was injected in doses of 10 μg/kg (8 experiments) intravenously, blood flow increased by 53 ± 16.4% ($p = 0.8$). The effect developed immediately after injection of the preparation and continued 5-7 minutes, after which the second phase - deceleration of the blood flow by 15 ± 2.5% ($p < 0.1\%$) - developed and lasted up to 15-20 minutes (Fig. 5B). Since pressure in the

carotic arteries was stabilized, this deceleration in blood flow was apparently caused by narrowing of the perfused vessels. A similar phase of deceleration in the blood flow after an initial acceleration was sometimes observed in experiments with lower doses of histamine (5 μg/kg), although it was not as pronounced.

Study of oxygen tension in brain tissues under stabilized arterial pressure showed that intravenous injection of histamine in doses of 10 μg/kg (6 experiments) first caused a short-term (up to first minute) decrease in PO_2 by 7 ± 3% (p = 7%). Thereafter, in most experiments there developed a more prolonged (5-8 minutes) increase in PO_2 by 6-30%. This two-phase change in PO_2 is reminiscent of the nature of changes in blood flow under conditions of unstabilized arterial pressure and, apparently blood flow did play a substantial role in the PO_2 changes. Evidence of this can also be found in the data of research on PO_2 in the brain under conditions of stabilized arterial pressure (3 experiments). Here PO_2 increased by 27-46% from the original values, and there was no phase of decrease in PO_2.

Discussion of Results

The study which we conducted showed that the decrease in tonus of the cranial vessels under the influence of acetylcholine and histamine generally occurred in parallel with a decrease in total arterial pressure. We know that a sudden drop in total arterial pressure causes a decrease in the tonus of the cranial vessels, regardless of the factor responsible for the general hypotension. Consequently, when hypotensive agents are introduced into the organism, there may occur an indirect reaction on the part of the cranial vessels in response to the drop in generaly arterial pressure and a direct reaction, which is the result of the immediate effect of the preparation on the vessels. The resistographic method makes it possible to determine the direct and indirect effect of pharmacological substances on the vessels [20]. When the volume of the perfusion system was intentionally increased, a "lag" was noted in the reaction of the cerebral vessels to intravenous injection of the preparations (Fig. 2, 4; interval a, b). These data indicate the predominantly direct effect of the acetylcholine and histamine on the tonus of intracranial and extracranial vessels.

The direct effect of acetylcholine and histamine on cranial vessels is also indicated by experiments with intracarotid injection of the preparation in doses of 0.1-0.5 μg/kg (14 experiments). In experiments in which resistography was used, the injection of acetylcholine into the basin of the intracranial vessels caused their tonus to decrease by 33 ± 5.3%. Here the resistance of the extracranial vessels and total arterial pressure changed substantially. The injection of the same doses of acetylcholine into the system of extracranial vessels caused an average decrease of 55 ± 4.7% in their tonus. The resistance of the intracranial vessels and total arterial pressure in this case remained essentially unchanged. We observed a similar pattern in intracarotid injection of the histamine. Noticeable here is the more pronounced effect for the extracranial vessels as compared to the intracranial, which is apparently related to the lower sensitivity of the latter to the studied preparations.

A comparison of the effect of acetylcholine and histamine on the cranial vessels and general arterial pressure shows that the cranial vessels are more sensitive to the histamine than to the acetylcholine, while there was a greater drop in general arterial pressure under the

effect of acetylcholine. The high degree of sensitivity of the vessels of the brain to the histamine is also indicated by certain data in the literature [22, 30]. However, under the effect of the histamine the cranial vessels frequently contract after their original expansion. Some authors explain this pressor reaction by the stimulating effect of the histamine on the sympathetic-adrenal system [24]. However, for the vessels of the brain this explanation is not well founded, since these vessels reacted only slightly to the effect of sympathetic nerves. We know that the products of metabolism (CO_2 and others) and also oxygen are powerful regulators of the brain's vessels. The fact that in our experiments the phase of constriction of the brain vessels was most pronounced after a sharp increase in the volume flow rate and ρO_2 of the brain tissue (experiments with pressure stabilization), gives us justification to explain the vasoconstrictor phase as the result of the change in the ratio between CO_2 and O_2 in the brain tissue. In direct confirmation of this hypothesis is also the fact that with a stabilized volume of blood (resistography method) the constrictor phase is generally absent.

The results of our experiments showed that the decrease

in general arterial pressure found significant reflection in brain blood circulation for the case of intravenous injection of the studied preparations, particularly acetylcholine. This was apparently one of the reasons for inconsistent treatment of the effect of these preparations on the vessels of the brain. We frequently encounter the deduction that the tonus of the brain vessels changes only on the basis of the change in the blood flow of the brain without corresponding stabilization of the pressure of the blood or its rate of flow. The sensitivity of the brain vessels to system also depends on the type of animal. Analysis of published data has revealed that in the case of rabbits most researchers observed the opposite reaction - constriction of the vessels of the brain in the case of intravenous injection of a histamine.

Conclusions

1. Intravenous and intracarotid injection of acetylcholine and histamine lower the tonus of the intracranial and extracranial vessels; the extracranial vessels react to a greater degree.

2. Changes in the volume rate of cerebral blood flow depend on the direct effect of the acetylcholine and histamine on the cerebral vessels and the general arterial pressure, which drops sharply when the preparations are injected intravenously.

3. Under conditions of stabilized pressure in the carotic arteries, acetylcholine and histamine increase the cerebral blood flow. Here we often find a two-phase reaction: an increase followed by a subsequent decrease in blood flow, particularly when the histamine is introduced.

4. Oxygen tension in the brain tissues changes in accordance with blood flow in the case of intravenous injection of the preparations.

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ABSTRACT

THE EFFECT OF ACETILCHOLINE AND HISTAMINE ON THE TONE OF CEREBRAL AND EXTRACRANIAL VESSLES, VOLUME RATE OF THE BRAIN BLOOD CIRCULATION, AND OXYGEN TENSION IN THE BRAIN TISSUE

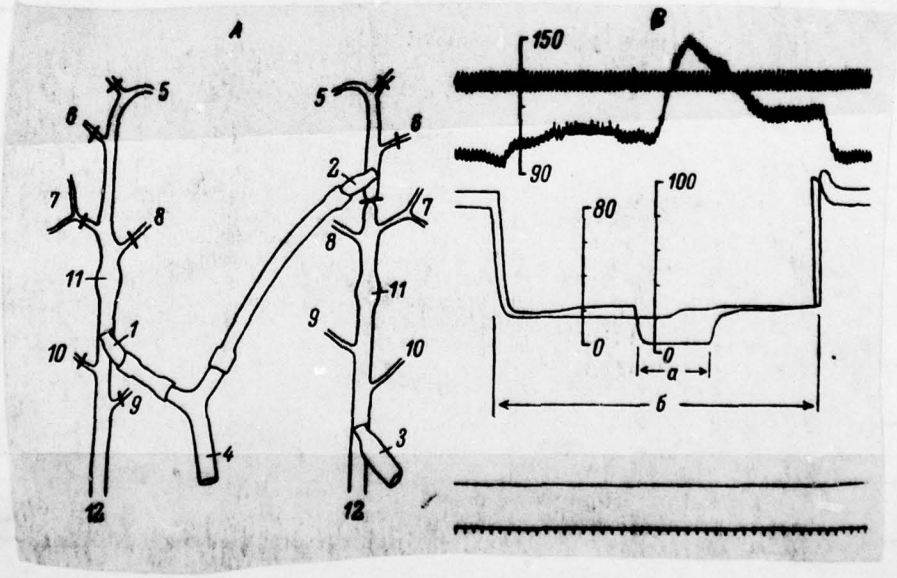
M. D. Haevy, S. P Troftmenko

Medical Institute, Semipalatinsk

Acute experiments were performed in 86 anesthetized cats under artificial respiration. The effect of drugs was studied by using resistography, rheoencephalography, flowmetry, and polarographic recording of oxygen tension in the brain tissue.

I. v. and intracarotid administration of the drugs produced dilatation of cerebral and extracranial vessels, more expressed in the latter The cerebral blood circulation was closely related to the extent of the systemic pressure drop, and to immediate response of cerebral vessels to the action of acetilcholine and histamine. At the nonstabilized regional tension, the cerebral circulation volume declined, this ensuing from a steep fall of the total arterial pressure. At the stabilized regional tension, the cerebral circulation volume always considerably increased. Oxygen tension in the brain tissue changed according to the blood circulation.

Fig. 1. A - system of vessel ligation in cat. 1, 2, 4 - cannulas and T-joined for perfusion of intracranial vessels; 3 - cannula for perfusion of extracranial vessels; 5 - branch for internal maxillary artery which supplies brain; 6-10 - extracranial branches of carotic arteries; 11 - carotid sinus; 12 - general carotic artery. B - check for anastomoses by inclusion of total carotic (interval *б*) and vertebral (interval *а*) arteries. From top to bottom: respiration (controlled), general arterial pressure, pressure in system of intracranial vessels, pressure in system of extracranial vessels, line for notation of stimuli, time marker - 5 s.



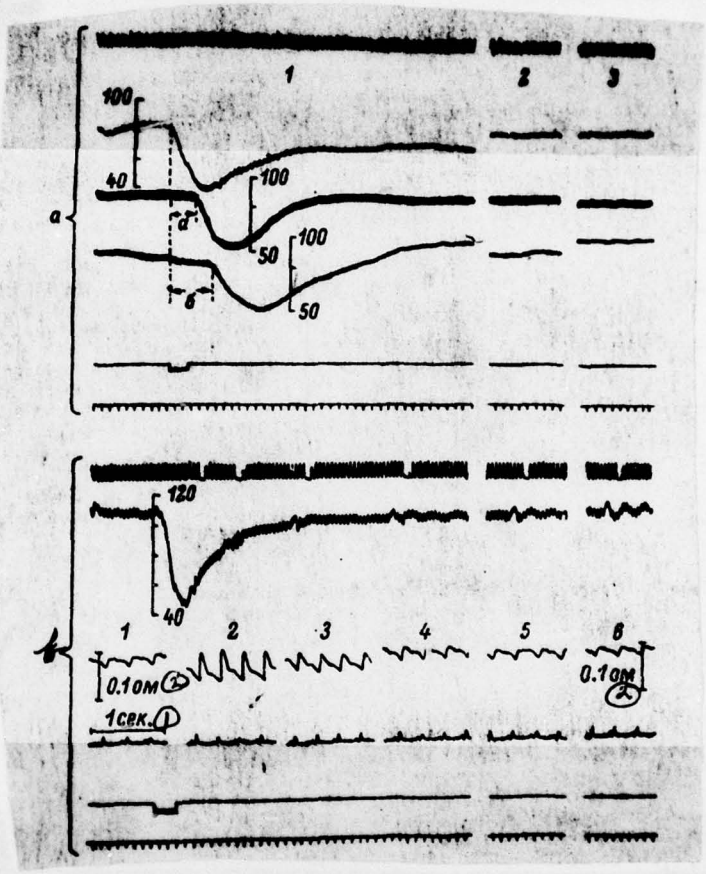


Fig. 2.

Fig. 2. Effect of acetylcholine (3 μg/kg - intravenous) on tonus of cranial vessels. а - from resistographic data. From top to bottom: respiration (control), general arterial pressure, resistogram of intracranial vessels, resistogram of extracranial vessels (a, b - result of deliberate increase in volume of perfused channels), marker for injection of acetylcholine, time marker - 5 s; 1 - at moment of injection; 2, 3 - within 5 and 10 minutes after injection of preparation. б - from rheoencephalcgraphic data. From top to bottom: respiration (control), general arterial pressure, REG, EKG, time marker - 5 s, marker for injection of acetylcholine; 1 - before injection of preparation; 2, 3, 4, 5, 6 - within 1, 2, 3, 5, and 10 minutes after injection. KEY: (1) s, (2) Ω.

Fig. 3. Effect of acetylcholine (3 μg/kg - intravenous) on volume rate of cerebral blood flow. a - unstabilized pressure in carotic arteries. From top to bottom: respiration (control), general arterial pressure, pressure in carotic arteries, volume rate of blood flow (distance between markers 2 ml); marker for injection of acetylcholine, time marker - 5 s; 1 - at moment of injection; 2, 3 - within 5 and 10 minutes after injection. *b* - for stabilized pressure in carotic arteries. Other symbols the same as in A.

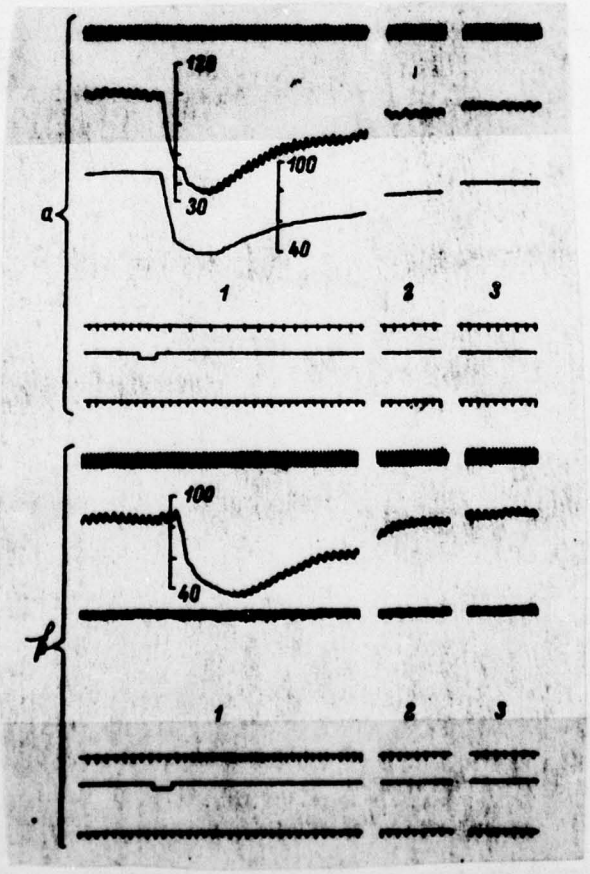


Fig. 3.

Fig. 4. Effect of histamine (10 μg/kg - intravenous) on tonus of cranial vessels. a - from resistographic data. 1 - at moment of injection of histamine; 2 and 3 - within 5 and 10 minutes after injection. b - from rheoencephalographic data. 1 - before injection of histamine; 2, 3, 4, 5 - within 1, 2, 5, and 10 minutes after injection. Other symbols the same as in Fig. 2.

Key: (1) ohm. (2) s.

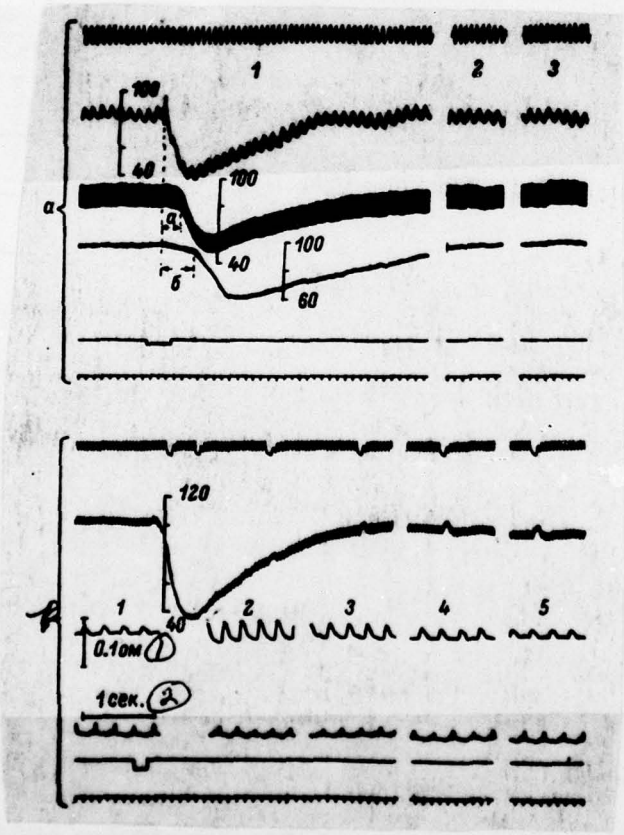


Fig. 4.

Fig. 5. Effect of histamine (10 μg/kg - intravenous) on volume rate of cerebral blood flow. a - for unstabilized pressure in carotic arteries. From top to bottom: 1 - general arterial pressure, volume rate of blood flow, distance between markers 2 ml, marker for injection of histamine, time marker - 5 s; 1 - at moment of injection of preparation; 2, 3, 4, 5 - within 5, 10, 20, and 40 min after injection. b - for stabilized pressure in carotic arteries. Other symbols the same as in a (second curve from the top - stabilized pressure in carotic arteries).

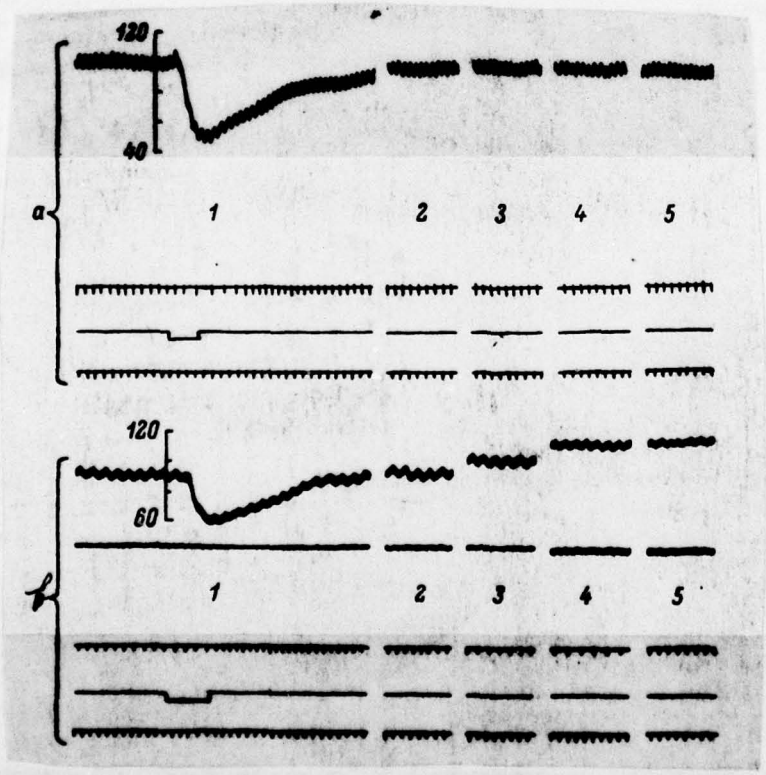


Fig. 5.

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