COMPARATIVE CHANGES IN VASCULAR RESISTANCE IN SKELETAL MUSCLE AND SMALL INTESTINE AFTER DESTRUCTIVE LESIONS IN THE VENTRAL MEDULLA

Academician B. I. Tkachenko and
V. A. Kul'chitskii

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Bilateral electrolytic destruction of structures in the rostral part of the ventral zones of the medulla causes the blood pressure to fall to the level observed after high cordotomy [4, 11, 12], whereas lesions in the caudal medulla cause an increase in the systemic blood pressure and a sharp rise of the plasma vasopressin level [3, 5, 7, 10]. However, there is information in the literature that only certain parameters of the systemic hemodynamics are changed (mean arterial pressure, heart rate) and there is a complete absence of data on changes in the visceral circulation. Another noteworthy fact is that in the investigations cited above, after electrocoagulation of brain structures not only were the bodies of neurons destroyed, but also en passant nerve fibers running in the rostral and caudal directions. This could be a source of erroneous information concerning the role of these structures in the central control system of the systemic and visceral hemodynamics.

The aim of this investigation was to compare changes in resistance in blood vessels of the gastrocnemius muscle and small intestine and also changes in the systemic blood pressure after electrolytic or chemical (L-glutamate) destruction of structures in the ventral medulla.

EXPERIMENTAL METHOD

Experiments were carried out on 25 cats weighing 2.1-3.9 kg, anesthetized with urethane (1.1 g/kg), subjected to thoracotomy and artificial ventilation, and receiving heparin (1000 U/kg). The vascular bed of the hemodynamically isolated gastrocnemius muscle (13 experiments) and small intestine (12 experiments) was perfused with autologous blood (at 37.5°C) by means of a constant delivery pump, by the method described previously [2]. To prevent any effect of an extravascular factor (changes in peristalsis) on the vessels of the small intestine atropine (0.3 ml) was injected intravenously.

A monopolar platinum electrode (diameter of tip 200 μm was fixed in the ventral part of the medulla by means of an MSh-80 step manipulator to a point 2 mm rostrally to the midpoint of emergence of the roots of the hypoglossal nerves (the point "+2 mm") or 2 mm caudally to this level (the point "−2 mm") at a distance of 4 mm laterally to the midline and at a depth of 1500 μm. Bilateral electrolytic destructive lesions were produced in the brain (17 experiments) by an anodal current (2 mA, for 20 sec). The reference electrode was secured in the cervical muscles. In eight experiments 3 μliters of 150 mM solution (pH 7.8-8.1) of L-glutamate (from "Sigma") were injected bilaterally into the points "+2 mm" or "−2 mm" at a depth of 1500 μm(4 mm laterally to the midline); L-glutamate destroys only the bodies of neurons and does not affect their processes [1, 9]. Glutamate was injected by means of an MSh-10 microsyringe (diameter of needle 200 μm) at the rate of 0.5 μliter/min. At the end of the experiments the location of the electrode tip and microneedle was verified histologically. The numerical data were subjected to statistical analysis by Student's t test.

EXPERIMENTAL RESULTS

Bilateral electrolytic damage to structures of the ventral medulla at the point "+2 mm" led after 2-3 sec to a fall of the systemic blood pressure (initial values 117.0 ± 4.6 mm Hg)

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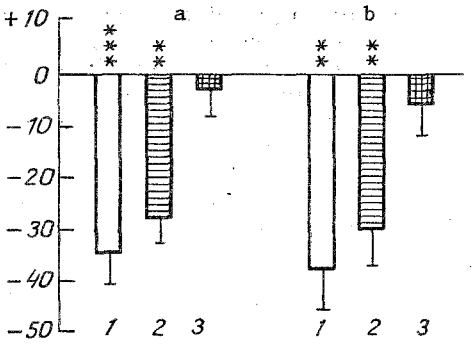

Fig. 1

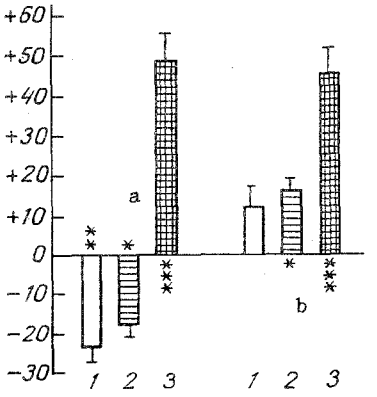

Fig. 2

Fig. 1. Changes in blood pressure and perfusion pressure in vessels of gastrocnemius muscle and small intestine 60 min after electrolytic destruction (a) or 30 min after chemical destruction (b) of structures in ventral medulla at the point "+2 mm" (in % of initial level). Here and in Fig. 2: 1) blood pressure; 2) perfusion pressure in vessels of gastrocnemius muscle; 3) perfusion pressure in vessels of small intestine: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Fig. 2. Changes in blood pressure and perfusion pressure in vessels of gastrocnemius muscle and small intestine 60 min after electrolytic (a) or chemical (b) destruction of structures in ventral medulla at the point "−2 mm" (in % of initial level).

and of the perfusion pressure in vessels of the gastrocnemius muscle (initial values 147.5 ± 5.9 mm Hg), which fell 120-150 sec after destruction of these structures by 34.9 ± 5.8 and 27.8 ± 4.5% of their initial levels, respectively, and thereafter remained stable for 60 min of observation (Fig. 1a); the perfusion pressure in vessels of the small intestine was virtually unchanged under these circumstances (11.6 ± 6.9 and 107.9 ± 5.8 mm Hg, respectively). After bilateral injection of glutamate into the point "+2 mm" changes in the systemic blood pressure and perfusion pressure in vessels of the gastrocnemius muscle corresponded to those after electrolytic injury to the above-mentioned structures in the ventral medulla: 60 min after electrocoagulation they had fallen by 37.9 ± 8.7 and 30.1 ± 7.4%, respectively, below their initial level; in the vessels of the small intestine the fall of perfusion pressure (by 5.8 ± 6.1%) was not statistically significant (Fig. 1b). It follows from these data that changes in the systemic blood pressure and regional vascular resistance after electrocoagulation or injection of glutamate into the point "+2 mm" in the ventral medulla are the result of destruction of neuron bodies located in this region and not of en passant nerve fibers. Histological verification (using the atlas [13]) showed that localization of the foci of destruction in these experiments corresponded to the ventral zones of the lateral paragigantocellular nucleus. It can be postulated, therefore, that the neurons of this nucleus form tonic neurogenic volleys to vessels of the gastrocnemius muscle and that they help to maintain the initial level of the blood pressure. Tonic neurogenic volleys to vessels of the small intestine evidently do not arise from these brain structures.

Bilateral electrolytic destruction of structures in the ventral medulla at the point "−2 mm" was followed after 2-3 sec by a slow and steady fall of the blood pressure and perfusion pressure in vessels of the gastrocnemius muscle, which had fallen by 24.3 ± 3.1 and 18.0 ± 2.7% of the initial level, respectively, 60 min after destruction; the level of perfusion pressure in vessels of the small intestine began to rise on average 7-10 min after destruction, and after 60 min it exceeded the initial level by 49.0 ± 5.6% (Fig. 2a). On histological verification [13] the location of the zone of injury in these experiments corresponded to the parvocellular and magnocellular subnuclei of the lateral reticular nucleus. Thus the fall of the level of the blood pressure and perfusion pressure in vessels of the gastrocnemius muscle after electrolytic destruction of structures in the caudal part ("−2 mm") of the ventral medulla was about one-third less marked than after a similar procedure on the rostral part of the ventral medulla ("+/2 mm"). After electrocoagulation of the ventral part of the lateral reticular nucleus an increase in perfusion pressure was observed

in vessels of the small intestine compared with its relatively stable level after destruction of ventral zones of the lateral paragigantocellular nucleus (Figs. 1a and 2a). After bilateral injection of glutamate at point "–2 mm" a slow but steady rise of perfusion pressure was observed in vessels of the gastocnemius muscle and small intestine (the latent period of this response was 20-30 min); 60 min after coagulation it was significantly higher than initially by 16.0 ± 2.7 and 44.9 ± 6.4%, respectively; the blood pressure in this case was increased on average by 12% (Fig. 2b; from 116.5 ± 5.1 mm Hg to 130.0 ± 5.7 mm Hg). Control injection of glutamate into the caudal zones of the lateral reticular nucleus [13] (3.5 mm caudally to the mid point of emergence of the roots of the hypoglossal nerves) had no significant effect on the systemic blood pressure or resistance of vessels of the gastrocnemius muscle and small intestine. It can be concluded, therefore, that the trend and intensity of changes in the systemic blood pressure and regional vascular resistance depend not only on the method used to destroy structures of the ventral zones of the medulla, but also on the location of the lesion in the brain stem.

Destruction of neurons in the ventral part of the lateral paragigantocellular nucleus was accompanied by a rapid fall, lasting several seconds, in the level of the systemic blood pressure and perfusion pressure in vessels of the gastrocnemius muscle, which could be due to blockade of neurogenic volleys to the sympathetic preganglionic neurons from these regions of the ventral medulla [4, 6, 8, 11]. Destruction of neurons of the parvocellular and magnocellular subnuclei of the lateral reticular nucleus was accompanied by a slow increase, lasting some tens of minutes, of the perfusion pressure in vessels of the gastrocnemius muscle and small intestine which, according to existing data [3, 5, 7, 10], could be the result of an increase in the concentration of vasopressor agents in the blood on account of destruction of the neuron system in the caudal part of the ventral medulla connected with the neurosecretory cells of the hypothalamus. Finally, since after destruction of neurons of the ventral part of the lateral paragigantocellular nucleus a significant fall of perfusion pressure was observed only in vessels of the gastrocnemius muscle (its changes in vessels of the small intestine were not significant), and after destruction of neurons of the ventral zones of the lateral reticular nucleus an increase in perfusion pressure was observed in both vascular regions studied, it can be concluded that selective (direct or indirect) volleys take place from structures of the ventral medulla to vessels of the gastrocnemius muscle or small intestine, which does not contradict the existing data [8].

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