A PRESSOR AREA IN THE CAUDAL PART OF THE VENTRAL SURFACE OF THE MEDULLA

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Two neuron populations — adrenergic and noradrenergic — are located on the ventral surface of the medulla. Adrenergic neurons are located in its rostral part and their electrical or chemical stimulation raises the blood pressure (BP) and increases ventilation of the lungs [1, 4, 5]. Noradrenergic neurons are located in the caudal part of this zone and their activation in most cases lowers BP [1, 3], although under deep anesthesia application of metrazol (which activates neurons) to this depressor zone of the ventral surface of the medulla causes BP to rise [2]. It has accordingly been suggested [2] that another pressor area, excitation of which by metrazol led to an increase in BP, may lie caudally to this depressor area.

The aim of this investigation was to determine the exact location of the caudal pressor area and to assess the effectiveness of its constrictor influence on vessels of the leg and small intestine.

EXPERIMENTAL METHOD

Experiments were carried out on 12 cats of both sexes weighing 2.1-3.2 kg, anesthetized with urethane (1.1 g/kg, intravenously), under open chest conditions and artificial respiration, and with the use of heparin (1000 U/kg).

The reference level on the ventral surface of the medulla was taken to be the point midway between emergence of the roots of the hypoglossal nerves (Fig. 1). Electrodes were inserted into the brain 2 mm rostrally (+2 mm) and 2 mm (—2 mm) and 4 mm (—4 mm) caudally to it. Insertion of the electrodes at the first two points was carried out 4 mm laterally to the midline (on the ipsilateral side relative to the test limb) to a depth of 2000 μ; at the third point (—4 mm) during insertion of the electrodes the maximal pressor effect was found in response to stimulation of the brain 3 mm laterally to the midline to a depth of 1000 μ. Bipolar electrodes were made from nichrome wire 100 μ in diameter, coated with fluorine plastic. The distance between the active regions of the electrodes was 100 μ.

A current of threshold strength and of twice or four times the threshold strength with constant frequency and duration of stimulation (50 Hz, 0.5 msec) was used for electrical stimulation of the brain. The threshold strength of current was defined as the minimal strength inducing a change of perfusion pressure in the vascular region tested. It varied in different animals from 5 to 50 μA, in agreement with data in the literature [4]. The duration of electrical stimulation was 120 sec.

In each experiment vessels of the leg and small intestine were perfused simultaneously by means of a constant output pump. For this purpose blood was taken from the abdominal aorta and passed through a heat exchanger by one channel of the pump into the popliteal artery to perfuse the leg muscles, and by the other channel into the intestinal artery to perfuse the small intestine. Changes in perfusion pressure and systemic BP were recorded on an ID-2K electromanometer connected to an N-327-5 automatic writer. To discover the greatest possible pressor reactions the sympathetic chains and splanchnic nerve were stimulated alternately by a current of increasing strength, duration, and frequency, whereas to assess depressor reactions the regional sympathetic nerves were divided at the end of the experiment. The animal's body temperature was kept at 37.5 ± 0.5°C. The results were subjected to statistical analysis by Student's t test.

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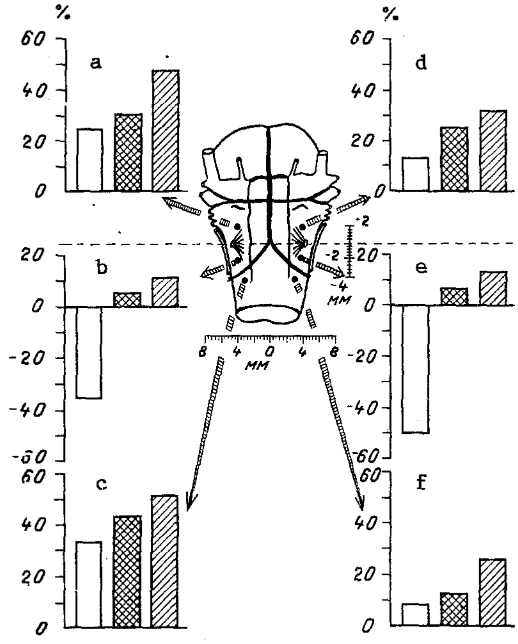

Fig. 1. Changes in perfusion pressure in vessels of leg and small intestine in response to electrical stimulation of ventral surface of medulla (shown schematically in center of figure). On left — degree of realization of responses of leg vessels (in % of maximal responses) to electrical stimulation of structures on ventral surface of medulla located 2 mm rostrally (a) and 2 and 4 mm caudally (b and c respectively) to reference point. On right — degree of realization of responses of small intestinal vessels (in % of maximal responses) to electrical stimulation of structures on ventral surface of medulla located 2 mm rostrally (d) and 2 and 4 mm caudally (e and f respectively) to reference point. Unshaded columns — changes in perfusion pressure (in % of maximal responses) to a current of threshold value; cross-hatching — to current of twice the threshold strength; oblique shading — to a current of 4 times threshold strength. Broken line drawn through middle of points of emergence of roots of hypoglossal nerves (reference level).

EXPERIMENTAL RESULTS

The background blood flow in the vessels of the leg in these experiments was 5.0-8.5 ml/100 g/min, and in the vessels of the small intestine it was 30-40 ml/100 g/min; the initial level of perfusion pressure in the vessels of the leg was 145.0 ± 2.0 mm Hg, compared with 100.5 ± 1.3 mm Hg in vessels of the small intestine. Stimulation of the sympathetic chains caused the perfusion pressure in the vessels of the leg to increase by 42.0 ± 7.5%, and division of the sympathetic chains lowered the pressure by 34.0 ± 6.6%. Stimulation of the splanchnic nerves led to an increase in the perfusion pressure in vessels of the small intestine by 95.0 ± 15.7%, and their division lowered the pressure by 15.0 ± 2.4%.

Electrical stimulation of the brain at point "+2 mm" by a current of threshold strength, followed by stimulation by currents of twice and 4 times the threshold strength caused a rise of perfusion pressure in the vessels of the leg and small intestine in all cases (Fig. 1). The increase in perfusion pressure in vessels of the leg and small intestine was found to be directly proportional to the strength of electrical stimulation of the brain at the point "+2 mm." The degree of realization of constrictor responses of the leg vessels (relative to maximal responses) was 1.5-2 times greater than the corresponding response in the small intestinal vessels to stimulation of the brain at the same point by currents equal to and 4 times stronger than the threshold value (Fig. 1).

In response to brain stimulation at the point "—2 mm" by a current of threshold strength the perfusion pressure fell in both vascular regions: in the leg vessels it was about 35% and in the small intestinal vessels about 50% of the dilator responses to division of the regional sympathetic nerves to the corresponding organ (Fig. 1). Thus the degree of realization of dilator responses in vessels of the small intestine to brain stimulation at the point "—2 mm" was about 1.5 times greater than the corresponding responses in the leg vessels. Stimulation of this part of the brain by currents of 2 and 4 times the threshold strength led to some increase in resistance of the vessels both of the leg and of the small intestine (Fig. 1), and by about the same degree (by 5-10%).

Stimulation of the brain caudally to this depressor area at different distances from the reference level and midline and at different depths of the brain led to an increase of perfusion pressure in the vascular regions studied; maximal vasoconstrictor responses were found to brain stimulation at a point 4 mm caudally to the reference level ("—4 mm"), 3 mm laterally to be midline, and at a depth of 1000 μ. Consequently, the great majority of neurons of the pressor area described above are concentrated in this caudal part of the ventral surface of the medulla. In response to their stimulation (at the point "—4 mm"), just as to stimulation of neurons of the rostral pressor area (at the point "+2 mm") the degree of increase of the perfusion pressure in both vascular regions studied was proportional to the strength of stimulation (Fig. 1). In the leg vessels the degree of realization of the constrictor responses during stimulation of neurons of the caudal and rostral pressor areas was comparable. In the small intestine, vasoconstrictor responses to stimulation of the caudal pressor area were 1.5-2 times weaker than to stimulation of the rostral area.

It must be emphasized that in the experiments described above electrical stimulation was applied to neurons of one half of the ventral surface of the medulla. It can be postulated that during stimulation of the whole neuron population of the depressor area on the ventral surface of the medulla ("—2 mm") realization of all 100% of dilatory responses in vessels of the small intestine and of about 70% of the vasodilator responses in the leg muscles is possible. During activation of the whole neuron population of the pressor areas (rostral or caudal) all 100% of possible constrictor responses in the leg vessels and about 50-60% of vasoconstrictor responses in the small intestine will be realized.

The character of the vasomotor responses, their intensity, and their dependence on the strength of stimulation were thus, on the whole, comparable in response to stimulation of the rostral pressor area ("+2 mm") described above and of the pressor area ("—4 mm") discovered by the writer in the caudal part of the ventral surface of the medulla.

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