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MAINTENANCE OF HYPERTENSION DURING AVERSIVE EMOTIOGENIC INFLUENCES AS A FUNCTION OF THE BARORECEPTOR REFLEX

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UDC 616.12-008.331.1-02:613.863]-092.9-07

KEY WORDS: arterial pressure; emotiogenic influences; baroreceptor reflex.

It was shown previously [2, 4] that under conditions of emotional stress due to aversive influences and accompanied by a raised arterial pressure (BP) the baroreceptor reflex is depressed. Meanwhile the positive emotional state induced by intracerebral self-stimulation does not change the baroreceptor reflex, although it also is accompanied by hypertension [1]. A direct connection has been noted in cats between depression of baroreceptor reflexes and the conditions of emotional strain and the absence of hypertensive responses to emotiogenic stimulation in animals with deafferentation of the carotid sinus and aortic reflexogenic zone [2, 4].

The object of this investigation was to discover whether the baroreceptor reflex is necessary to maintain the hypertensive response to emotiogenic stimulation of varied genesis in laboratory rats.

EXPERIMENTAL METHODS

Experiments were carried out on 12 conscious rats (180-250 g) into whose aorta (through the carotid artery) and external jugular vein catheters had been introduced 1-5 days before the experiment, under anesthesia (pentobarbital sodium, 45 mg/kg), to record the systemic BP and the period of the cardiac contractions, and to inject phenylephrine (0.01-0.1 mg/kg) intravenously. At the same time, the sinus, aortic, and superior laryngeal nerves and the cervical sympathetic trunks were divided in most of the animals, to completely denervate the mechanoreceptor zone of the aortic arch and carotid sinuses. In three rats the mechanoreceptor zones were denervated after experiments to study changes in the hemodynamics during aversive and positive emotiogenic stimulation. A negative emotional state was induced in the animals by a loud acoustic stimulus (the ringing of a bell) for 15 sec, which was combined during the period of conditioning with nociceptive stimulation of the base of the tail (30 stimuli/sec; 1 msec; 2-3.5 mA; 10 sec). To simulate a positive emotional state the method of electrical stimulation of the lateral hypothalamic region (diameter of electrode 150 μ), with parameters of 100 stimuli/sec, 1 msec, 10-250 mA, was used. The positive-reinforcing properties of self-stimulation were studied by the technique of pedal self-stimulation under two conditions: with no limitation of the time for closing the electrical circuit (free conditions), or under conditions of a burst of stimuli with fixed duration of 0.5 sec (fixed conditions).

Department of Experimental Cardiology, Scientific-Research Institute of Cardiology, Leningrad. (Presented by Academician of the Academy of Medical Sciences of the USSR B. I. Tkachenko.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 101, No. 5, pp. 548-550, May, 1986. Original article submitted March 25, 1985.

0007-4888/86/0005-0597$12.50

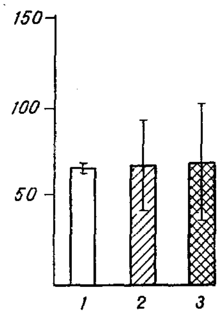

Fig. 1. Mean BP of rat with intact (1) and deafferented baroreceptor zones of aortic arch and carotid sinuses on 1st (2) and 5th (3) days after operation. Ordinate, BP (in mm Hg). Vertical lines, confidence intervals.

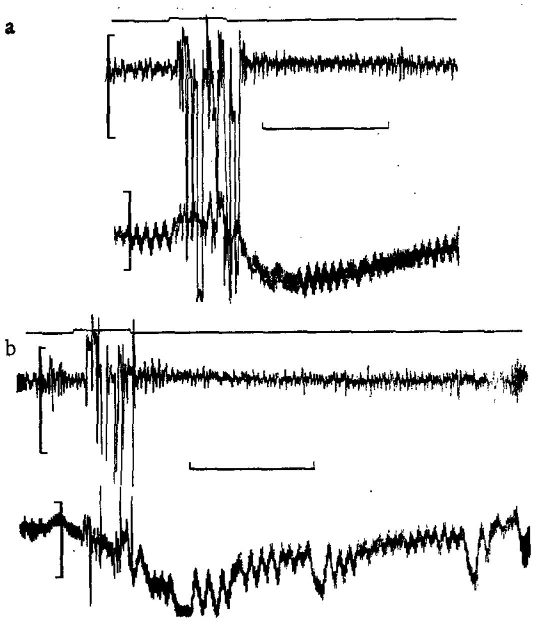

Fig. 2. Changes in hemodynamics in response to nociceptive stimulus in different rats (a, b). From top to bottom: marker of stimulation, intersystolic interval (calibration 100 msec), BP (calibration 40 mm Hg). Time marker 10 sec.

RESULTS

BP both of intact conscious rats and of the animals 1-5 days after deafferentation of the aortic arch and carotid sinuses was 65-85 mm Hg, but in rats with divided "baroafferent" nerves the pressure was labile and its fluctuations exceeded the mean level by 50-60 mm Hg and fell below it by 20-40 mm Hg. Values of BP of the same rat before and after total denervation of the mechanoreceptor zones of the aortic arch and carotid sinuses on the 1st and 5th days after the operation are shown in Fig. 1. BP was calculated on the basis of continuous recording for 10 min in an animal in its usual environment.

The response to an unconditioned stimulus did not differ in the behavioral parameters of animals with denervated mechanoreceptor zones from those in rats with intact sinus and aortic nerves: The animals bit the electrodes and exhibited vocalization. Thresholds of nociceptive responses in the animals of both groups were virtually indistinguishable.

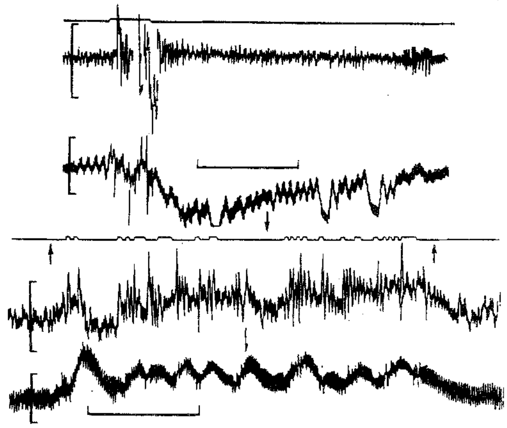

Fig. 3. Changes in BP and intersystolic interval in response to conditioned stimulus (a) and to self-stimulation (b). From top to bottom: marker of stimulation (a) or self-stimulation (b), intersystolic interval (calibration 100 msec), BP (calibration 40 mm Hg). Time marker 10 sec.

TABLE 1. Mean Parameters of Self-Stimulation in Rats before (I) and after (II) Deafferentation of Aortic Arch and Carotid Sinuses

Parameter	Free conditions		Fixed conditions	
	I	II	I	II
Mean number of times rat pressed lever during session	57±12	86±8	214±41	242±16
Total duration of presses, sec	180±40	210±26	191±14	199±21
Mean duration of one reinforced press, sec	3,2±1,9	2,4±0,1	0,5±0,1	0,5±0,2

Nociceptive stimulation of intact rats led to a rise of BP. Changes in BP of rats with divided "buffer" nerves (eight animals) in response to the nociceptive stimulus consisted either of hypotension with marked arrhythmia and peaks of BP at times of extrasystoles up to 35-40 mm Hg, followed by hypotension for a duration of 20-30 sec (Fig. 2a) or a fall of BP by 40-45 mm Hg for a period of 35-40 sec (Fig. 2b). Both subtypes of hypotensive responses could be observed in all the animals, but the character of the arrhythmia was preserved — the intersystolic interval varied from 105 to 450 sec.

In response to a conditioned stimulus during the first 2-4 sec of acoustic stimulation the rats became uneasy, shifted from one limb to another, and then died. BP of the intact rats rose (by 12-20 mm Hg), whereas in all animals after division of the nerves maintaining afferent innervation of the mechanoreceptors of the aortic arch and carotid sinuses, the acoustic stimulus evoked hypotension (15-30 mm Hg, Fig. 3). This hypotension was accompanied by shortening of the intersystolic interval, but not significantly, and by extrasystoles. After the acoustic stimulus ceased, the hypotension continued for 8-30 sec. This character of the hemodynamic response to the conditioned (and unconditioned) stimulus was maintained throughout the period of observation (up to 30 days). Methylatropine (5 mg/kg) did not affect the degree of hypotension.

Hemodynamic correlates of the self-stimulation reaction were studied in five experiments. As will be clear from Table 1, after denervation of the aortic arch and carotid sinuses the intensity of self-stimulation was very slightly higher than in rate with intact "baroafferent" nerves. Just as in intact rats, self-stimulation was accompanied by a long and considerable rise of BP (Fig. 3), up to 26 ± 2 mm Hg (in animals with intact nerves it was 17 ± 4 mm Hg), and this was maintained in the period between pressings of the lever. Under these circumstances (just as in intact rats) hypertensive responses of the order of 35-60 mm Hg were observed in response to application of pulses of current. Characteristically a marked rise of BP was observed as soon as the animals saw the lever, pressing of which led to the sending of square pulses into the hypothalamus (Fig. 3).

The results thus showed a difference in the mechanisms of the rise of BP during exposure to emotiogenic stimuli of different genesis. Whereas in positive emotions the baroreceptor reflex prevents hypertension, in rats, just as in cats [2-4] with denervated mechanoreceptor zones of the carotid sinuses and aortic arch, aversive emotiogenic stimulation does not cause BP to rise. This suggests that the maintenance of hypertension during aversive emotiogenic stimulation is one function of the baroreceptor reflex.

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EFFECT OF CONTRALATERAL COOLING OF THE CEREBRAL CORTEX ON INTRAVITAL MORPHOMETRIC CHARACTERISTICS OF THE PIAL VASCULAR NETWORK OF THE ASSOCIATION AND PROJECTION AREAS IN CATS

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UDC 616.831.31-001.19-031.4-092.9-07:
616.831.31-005-031.15-091

KEY WORDS: interhemispheric relations; compensatory processes in the cortex; blood supply to the cortex; pial vascular network.

Unilateral local injury to the cortex is accompanied by modification of its integrative activity and activation of interhemispheric interactions, leading to compensation and restoration of the disturbed functions [5, 7]. During the formation of a new pattern of adequate blood supply to the cortex differences are found in the character of changes in the volume velocity of the blood flow in individual areas [12, 13]. In the modern view, it is the system of pial vessels that is responsible for the precise correlation of function and blood flow, manifested at all levels of structural organization of the cortex [6, 9, 10, 11]. Close attention is currently being paid to its intrinsic organization [3, 4, 8]. However, structural and functional relations in the organization of the cortex and pial network have so far received little study. This is particularly true of the structure and properties of the pial system in morphologically and functionally different cortical regions belonging to association and projection systems of the brain [1, 2]. Yet it is these properties which largely determine the dynamic and reserve capacity of the vascular system of these formations during compensatory reorganization of cortical activity after injury.

The aim of this investigation was to determine the principal morphometric parameters and structural characteristics of the pial vascular system in the cortical association and projection areas of the cat under normal conditions and the dynamics of its state in the intact hemisphere during contralateral injury.

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 0007-4888/86/0005-0600$12.50