REFLEX INHIBITION OF EVOKED NOCICEPTIVE RESPONSES IN THE PARAFASCICULAR COMPLEX AND POSTERIOR VENTROMEDIAL THALAMIC NUCLEUS DURING ELECTROACUPUNCTURE IN CATS

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Electroacupuncture (EAP) has nowadays found wide application for the treatment of various pain syndromes [1, 4, 11]. The successful use of EAP in clinical practice provided a stimulus for experimental research aimed at studying the mechanisms of reflex analgesia and improving and enhancing the effectiveness of the method.

EAP is known to inhibit evoked nociceptive responses selectively at different levels of the CNS [6, 8, 11]. In the modern view the thalamic nuclei are among the main subcortical bran structures in which nociceptive information is integrated for onward transmission to the cerebral cortex [2, 3, 13].

In connection with the facts described above there was definite interest in the study of the effect of EAP on activity of neuron populations in specific and nonspecific zones of the thalamus during nociceptive afferentation and also during the arrival of signals of other sensory modalities, and the investigation described below was undertaken for this purpose.

EXPERIMENTAL METHOD

Acute experiments were undertaken on 24 adult cats anesthetized with hexobarbital (40 mg/kg, intraperitoneally) and immobilized with muscle relaxants, and artificially ventilated. The animal was secured in a stereotaxic apparatus and the fixation points (except the ears) were infiltrated with 0.5% procaine solution. The recording electrodes, consisting of steel wire 100-200μ in diameter, insulated throughout except at the tip (diameter 50μ), were inserted into the test structures in accordance with stereotaxic coordinates of an atlas of the cat's brain [10]. The reference electrode was fixed to the skull.

Nociceptive responses were evoked by a single electrical stimulation of the dental pulp (lower incisor) with square pulses (1 msec, up to 20 mA). To obtain tactile responses the lower lip was stimulated through bipolar needle electrodes with square pulses (0.1 msec, up to 5 mA).

EAP was performed through three acupuncture needles inserted into different points of the concha auriculae, to which square pulses of current (1.2 msec, 12-16 mA, 3 Hz) were applied for 15-30 min. Evoked potentials (EP) were estimated after averaging of 32 presentations by specialized computer. To monitor the animal's functional state the arterial pressure and ECG were recorded. After the end of the experiment the animal was given a lethal dose of hexobarbital and the brain removed for histological verification of the position of the tip of the recording electrode.

EXPERIMENTAL RESULTS

In the experiments of series I the effect of EAP on the amplitude of EP in the posterior ventromedial nucleus of the thalamus to nociceptive stimulation of the pulp of the canine tooth and to non-nociceptive stimulation of the region of the lower lip was studied. The focus of maximal activity of the potentials was determined in the ventromedial part of the nucleus, where sensation of the facial part of the cat's head is represented [3]. The EP to stimulation of the dental pulp consists of a positive–negative wave. The duration of the positive computer was 38 $\pm$ 4.2 msec, the amplitude of the whole response was 190 $\pm$ 36.2 μV, the latent period 8 $\pm$ 3.4 msec (Fig. 1B, I). The EP to stimulation of the lower lip had a similar configuration, with the following parameters: duration of the positive component 34.5 $\pm$ 2.4 msec, amplitude 235 $\pm$ 40.1 μV, latent period 5.5 $\pm$ 2.3 msec.

After auricular EAP inhibition of EP in response to stimulation of the pulp was observed (Fig. 1B: 2-3). The amplitude of EP 3-5 min after the end of EAP was 50% of the control value. Inhibition continued for 30-40 min, after

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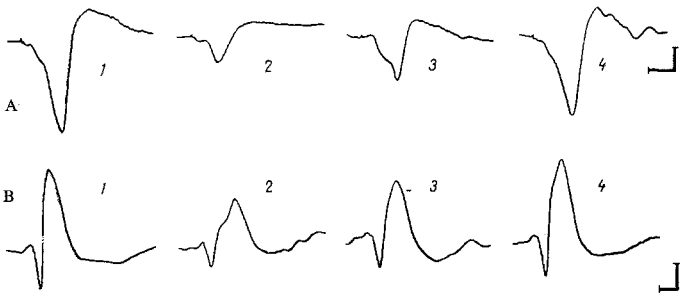

Fig. 1. Inhibition and restoration of amplitude of EP during nociceptive stimulation of dental pulp in parafascicular complex (A) and posterior ventromedial thalamic nucleus (B) after EAP. 1) Control; 2) 3 min; 3) 30 min; 4A) 90 min; 4B) 60 min after EAP.

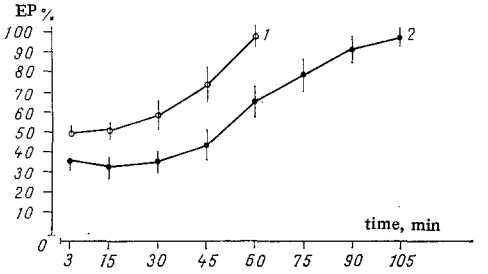

Fig. 2. Graph showing recovery of amplitude of EP after EAP: 1) in posterior ventromedial thalamic nucleus; 2) in parafascicular complex.

which the amplitude of the response gradually increased in the course of 20-30 min up to the control level (Fig. 1B:4, Fig. 2, I). The amplitude of the response to tactile stimulation of the lip was practically unchanged after EAP. No statistically significant changes in the duration of the EP phases and latent periods were observed.

In the experiments of series II inhibition of evoked responses to nociceptive and tactile stimuli in the parafascicular complex of the thalamus by EAP was estimated. The focus of maximal activity to stimulation of the pulp of the canine tooth was determined in the ventral part of the complex. Responses appeared after a latent period of 57.9 $\pm$ 9 msec; they had a well marked positive wave with amplitude up to 103.6 $\pm$ 52.3 μV and a duration of 141 $\pm$ 9.8 msec (Fig. 1A, I). The EP in response to tactile stimulation had a steeper front of its positive wave, which was of rather greater amplitude (146.7 $\pm$ 40.5 μV), a duration of 130 msec, and a latent period of 45.3 $\pm$ 7.3 msec.

After EAP considerable depression of the amplitude of EP was observed – down to 70% of the control level of responses to nociceptive stimulation (Fig. 1A: 2-3). Depression of the amplitude of the positive component lasted 45-50 min, and during the next 50-60 min the EP gradually recovered to the control values (Fig. 1A:4, Fig. 2:2). The amplitude of the tactile EP did not change significantly after EAP. Other parameters of EP in response to nociceptive and tactile stimulation also remained practically unchanged.

According to the results of clinical observations and experimental investigations the dental pulp is innervated by high-threshold A-delta and C-fibers, excitation of which produces pain sensations [5, 7]. Lowering of the amplitude of evoked responses during stimulation of the dental pulp in the thalamic nuclei after EAP and the very small change in the value of EP in response to tactile stimulation thus confirmed the view that EAP can induce an analgesic effect while not affecting signals of other sensory modalities [1].

The fact that evoked nociceptive responses are inhibited more substantially, as regards both amplitude and duration, in the medial zone of the thalamus (Fig. 2:2), in the nuclei of the posterior group [12], compared with specific zones of the thalamus suggest that these groups of nuclei are responsible for nonspecific activation of cortical regions during nociceptive stimulation evoking painful sensation. The projection relay nuclei transmit information to the cerebral cortex mainly about the spatial distribution of the stimulus and its physical parameters. The change in amplitude of EP in these nuclei after EAP is evidence of blockage of incoming nociceptive afferentation at neurons of the relay nucleus. The less marked depression of nociceptive responses during stimulation of the dental pulp in the ventromedial thalamic nucleus

compared with nuclei of the posterior group and with the parafascicular complex is evidently associated with activation of a certain proportion of the tactile fibers which enter in the composition of the alveolar nerve. The medial zones of the thalamus receive afferent impulses along fibers with higher thresholds [3, 9] than projection fibers, and this evidently explains the greater degree of depression of nociceptive EP after EAP in precisely those zones of the thalamus.

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EFFECT OF ACTH$_{4-7}$ AND LYSINE-VASOPRESSIN ON ACTIVITY OF A GENERATOR OF PATHOLOGICALLY ENHANCED EXCITATION

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Generators of pathologically enhanced excitation (PEE) are one of the most general pathogenetic mechanisms of different forms of pathology of the CNS [5]. The special features of their activity and, in particular, their ability to maintain activity for a long time indicate that PEE generators can be regarded as a unique form of pathological memory [5]. A similar view has also been expressed on foci of epileptic activity [3], which can be regarded as a special form of PEE generator. Consequently the study of behavior of generators and their relations to substances affecting different types and manifestations of memory is of particular interest. It was shown previously that an "extinct" and clinically silent PEE generator can be reactivated by suboccipital injection of a synthetic hexapeptide of definite structure [9].

In the investigation described below the effect of ACTH fragment ACTH$_{4-7}$ (synthesized in the Institute of Molecular Genetics, Academy of Sciences of the USSR, by M. A. Ponomareva-Stepnaya and V. N. Nezovibat'ko) and of lysine-vasopressin (obtained from Serva, West Germany), which play a definite role in consolidation processes in physiological memory [2, 16], on activity of PEE generators was studied.

EXPERIMENTAL METHOD

Experiments were carried out on noninbred albino rats weighing 200-220 g. The PEE generator was formed by the method described previously [5, 8] in the anterior horns of the lumbosacral segments of the spinal cord by means of tetanus toxin (TT), which disturbs different types of inhibition [5, 10, 13-15]. TT was injected in a dose of 1/25 MLD (for rats of the above weight) into the leg and thigh muscles of the left hind limb, from which, as special investigations

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