

ELECTROENCEPHALOGRAPHIC DATA CONCERNING THE CORTICAL AND SUBCORTICAL EFFECT OF MUD APPLICATIONS

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The study of the mechanism of action of medicinal muds on the organism is of great theoretical and practical interest in connection with their wide use in balneology.

The leading role played by neurogenic mechanisms in the development of the balneologic reaction of the organism to the action of medicinal mud has received general recognition.

A number of authors have investigated the central mechanisms regulating balneologic reactions [1, 2, 3, 4, 5], and the majority conclude that inhibitory processes predominate over excitatory processes in the cerebral cortex during balneologic reactions.

In order to study the dynamics of the main nervous processes during the action of mud applications on the organism, and to establish the interrelations of the cortex and subcortical centers during this action, electroencephalographic technique was used in the present work.

METHODS

Electric activity of the cerebral cortex and subcortical centers was recorded in series experiments on dogs with implanted electrodes, placed in the fronto-parietal area by the A. B. Kogan technique and in the basal region of the brain (hypothalamus) by the G.Ya. Khvoles method [7]; unipolar recording was used.

Screw electrodes with the inner shaft of silver or platinum were screwed into the frontal bone at the margin of the temporal bone and into the basal bone at the margin of the palatine bone at the base of the skull. The screw electrodes only made contact with the dura, without penetrating into the substance of the brain. Insulated leads from the electrodes were externalized in the scalp. The lead from the basal electrode was externalized through the nasal passages.

The bioelectric processes were recorded by means of a two-channel ink-writing oscillograph from the Experimental Plant of the Academy of Medical Sciences of the USSR. The medicinal mud used was the hydrogen sulfide silt from the salt-water Karasor lake (Karaganda region).

The medicinal properties of this mud have been confirmed by clinical and laboratory investigations at the Karaganda Medical Institute. The mud was applied to the shaved skin of the back or abdomen after warming it to 42°; the applications lasted for 30 minutes.

RESULTS

The experiments performed (38 experiments on 4 dogs) gave the following results.

As soon as 5 minutes after application of the mud an increase in electric activity of the fronto-parietal cortex and subcortical centers was noted. All the experimental animals showed an increase in amplitude and frequency of the waves.

Contrasting changes in the cortical and subcortical (hypothalamic) electroencephalogram occurred at the 30th minute of the mud application; there was a sharp drop in the frequency and amplitude of fast activity with the appearance of slow waves of high voltage.

The electric activity of the brain continued to diminish during one hour following the removal of the mud application; after 2 hours the initial electric activity of the cortex and subcortical centers was restored.

When mud had been applied ten-twelve times the amplitude of the cortical and hypothalamic potentials decreased and large numbers of slow waves appeared. The initial electroencephalographic picture was re-established approximately two weeks after cessation of medicinal mud applications. Changes in the electric activity of the brain under the influence of these applications were accompanied by considerable lowering of general reactivity of the animals and drowsiness.

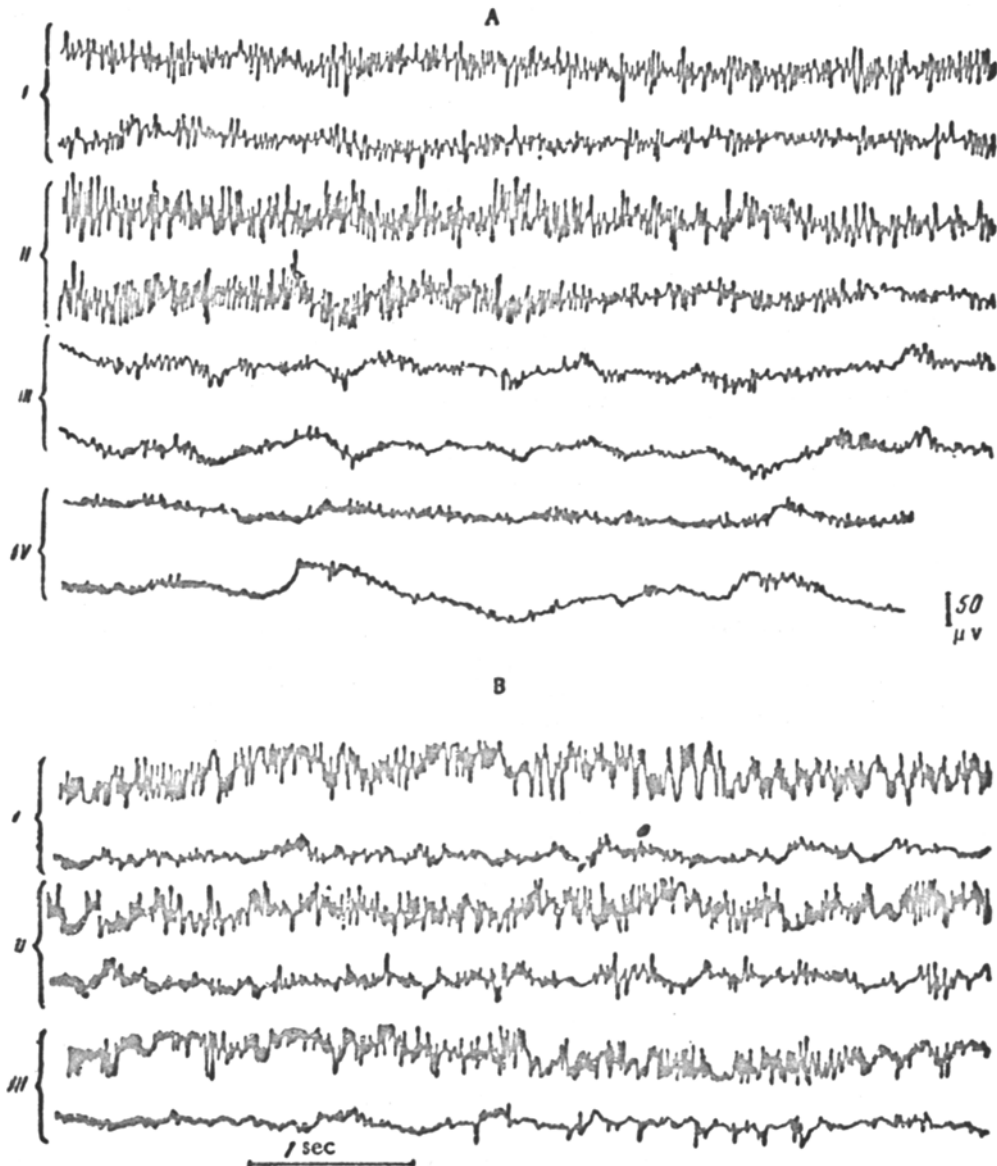


Fig. 1. A) Effect of mud applications on the electric activity of the cortex and subcortical centers. Dog Tobik. Effect on electric processes of the cortex and anterior hypothalamus. I) Initial electroencephalograms; II) 8 minutes after application of mud; III) the same after 30 minutes; IV) 60 minutes after removal of mud application. B) Effect of boiled and aired medicinal mud, warmed to 42°, on electric processes of the cortex and subcortical centers (control experiment). I) Initial electroencephalograms; II) 30 minutes after application of warmed aired and boiled down mud; III) 30 minutes after removal of temperature stimulus.

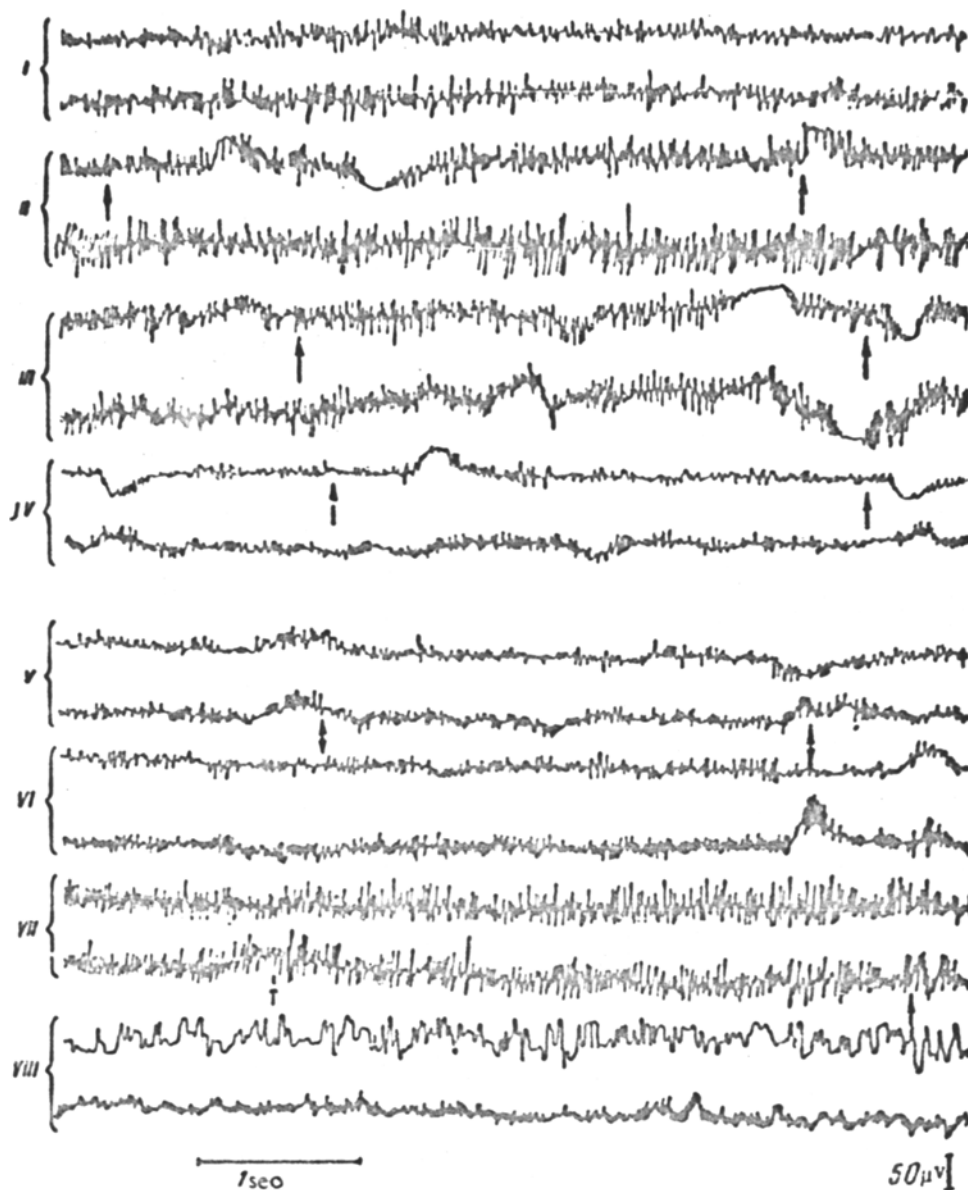


Fig. 2. Effect of mud applications on electric activity of the cortex and "anterior" hypothalamus. Dog Bulldog.
 I) Initial electroencephalograms; II) with auditory stimulation; III) 6 minutes after application of mud; IV) after 30 minutes; V) 30 minutes after removal of mud application; VI) the same after 60 minutes; VII) the same after 2 hours; VIII) after 10 applications of mud over a month. ↑ - beginning, ↓ - end of auditory stimulation.

Thus, auditory stimuli of 50 cps administered prior to application of mud always evoked an increase in fast activity with increase in its voltage, both in the cortex and the hypothalamus. Moreover, single large slow waves also appeared. On cessation of auditory stimulation prolonged after-effect was seen. Under the influence of mud applications, as early as the 30th minute there was considerable lowering of the reactivity of the cortex and subcortical centers; the changes in electric activity described above were no longer elicited by auditory stimulation.

This lowering of cerebral reactivity was observed for as long as 60 minutes following removal of mud applications, and the initial reaction to auditory stimulation was only restored after 2 hours.

To illustrate the effect of mud applications on the electroencephalogram, details of experiments on the dogs Tobik and Bulldog are given below.

Dog Tobik, weight 18 kg.

Prior to mud application (Fig. 1, A, I) the electroencephalogram showed fast activity - about 35 cycles per second, amplitude 25-100 μ v - in the fronto-temporal area and activity at about 30 c/sec with an amplitude of up to 60 μ v in the hypothalamus. Slower waves were practically absent from the cortex and subcortical centers. 8 minutes after application of the mud to the skin of the back the electroencephalogram (Fig. 1, A, II) showed increase of electric activity expressed in increased frequency of fast activity to 40-45 c/sec and in increase of its amplitude to 200 μ v in the cortex and 100-150 μ v in the hypothalamus. 30 minutes after application of the mud the electric activity decreased considerably both in the cortex and in the subcortical centers, down to 20-25 c/sec and amplitude of 10-20 μ v. Together with this change high voltage slow waves at 2-3 c/sec also appeared (Fig. 1, A, III). The dog was drowsy, reacting sluggishly when called. Marked lowering of electric activity still remained 60 minutes after removal of the mud application (Fig. 1, A, IV).

To exclude the effect of the temperature factor (temperature of the mud was $+2^{\circ}$) on cerebral electric processes during applications of the mud, in a number of control experiments hot-water bottles at 42° were placed against the skin of the dog's back; in other control experiments applications were made of boiled and aired mud at the same temperature.

As can be seen from Fig. 1, B, very insignificant changes in the electric activity of the cortex and subcortical centers occurred under the influence of boiled down and aired mud, warmed to 42° .

The effect of mud applications on the electric response of the brain to auditory stimulation is illustrated by the experiment performed on the dog Bulldog, weighing 16 kg.

The electroencephalograms show that auditory stimulation (50 cps) increases the frequency and amplitude of fast activity in the cortex and hypothalamus (Fig. 2, I-IV). 6 minutes after application of the mud the electric activity of the brain increased (Fig. 2, III) while auditory stimulation no longer enhanced the frequency and voltage of fast activity but only evoked large slow waves, mainly in the subcortical regions of the brain. After 30 minutes the cortical and subcortical activity diminished considerably (Fig. 2, IV) and remained at a low level - 30 (Fig. 2, V) and 60 (Fig. 2, VI) minutes after removal of the mud. Normal cerebral reaction to auditory stimulation, in the form of increased amplitude and frequency of the waves, returned only after 2 hours following removal of the mud (Fig. 2, VII). Fig. 2 (VIII) shows that under the influence of mud applications repeated ten times the dog Bulldog exhibited slow rhythms - at 5-6 c/sec in the cortex and at 15-20 c/sec, instead of 35 c/sec, in the hypothalamus.

In summarizing the data of these experiments on the effect of mud applications on the electric processes of the brain we are led to the conclusion that under this influence on the organism there is predominance of inhibitory over excitatory processes in the cortex and subcortical centers. Thus, mud applications produce marked lowering of the electric activity of the brain following a brief initial enhancement of such activity; there is also considerable diminution of cortical and subcortical reactivity to auditory stimulation and development of drowsiness. Prolonged use of mud applications enhances inhibitory processes. Data obtained from control experiments with boiled down and aired mud show that the action of medicinal mud on the central nervous system can be explained only by the presence in it of active chemical components (including hydrogen sulfide), and not by the thermal effect.

The data obtained in these experiments demonstrate the participation of the central nervous system in balneologic reactions of the organism to medicinal mud applications and show the nature of the changes occurring in the CNS.

SUMMARY

The dynamics of the fundamental nervous processes of the cortical and subcortical centers were studied during mud applications to the skin surface. The method of encephalography was employed. Series experiments were conducted on 4 dogs with implanted electrodes. An initial short increase in electric activity was noted. In 5 minutes after the application of medicinal mud from Karasor lake such increase in electric activity was revealed in the cortex of fronto-parietal area, as well as in the hypothalamus in the form of increased frequency and amplitude of electric potentials. Contrary to this in 30 minutes after mud application the

frequency and amplitude of rapid oscillations was decreased, while slow waves with large amplitude appeared. The electric activity of the brain returned to the initial stage in 2 hours after removal of mud applications. These investigations prove the prevalence of inhibitory processes over excitation in the central nervous system at the time when mud is applied to the skin surface.

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