A CASE OF HYPERKINESIA CAUSED BY UNILATERAL INJURY TO THE MEDIAL PART OF THE THALAMUS IN A DOG

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The question of the central mechanisms of clonic convulsions has been widely discussed in the clinical literature. Some authors ascribe the decisive role in the genesis of these convulsions to the cerebral cortex [7-11, 14]; others describe cases in which clonic convulsions have developed in association with lesions of the subcortical formations—the nucleus of Luys, the substantia nigra, the globus pallidus, the putamen, the medial portions of the thalamus [2, 6, 14]. Besides clinicians, physiologists have described motor disturbances in animals in the form of involuntary rhythmic spasms of the limbs, clonic convulsions, rotary movements of the head and trunk in the presence of stimulation or injury of certain subcortical formations, notably the nuclei of the thalamus [5, 12-15].

There are reports in the literature of a beneficial action of chlorpromazine [8, 10], metamizil, methyldiphacil, and other neurotropic drugs [1, 4] in the treatment of hyperkinesias. N. P. Bekhtereva and co-workers [2, 3] have used the method of polarization and electrolytic destruction of the ventrolateral nuclei of the thalamus with success in clinical practice for the suppression of hyperkinesias.

The object of this investigation was to analyze the constant rhythmic nodding movements of the head of an experimental dog appearing after injury to the group of nuclei of the medial thalamus.

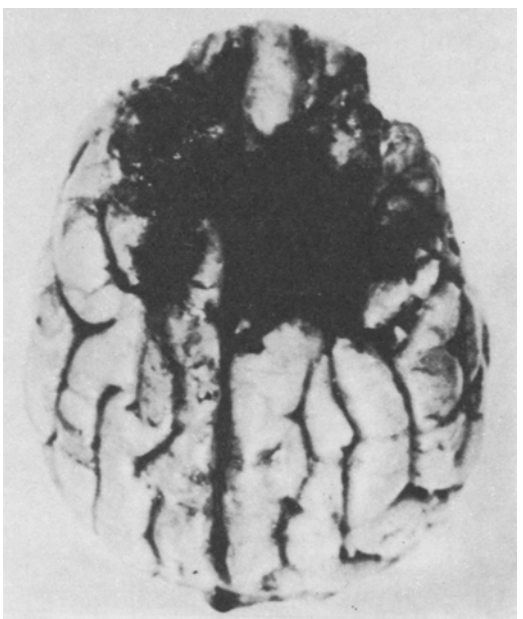

Fig. 1. The brain viewed from above.

EXPERIMENTAL METHOD

One of the experimental dogs, on July 3, 1963, had bipolar electrodes (diameter of wire 0.5 mm) implanted into the medial thalamus on the left side to a depth of 30 mm. The electrodes remained in the brain for 4 months 13 days, after which they were removed. On the 13th day after their removal the dog developed weak, rhythmic nodding movements of the head downward and to the left, and these became more marked every day.

To determine the possible mechanism of this form of hyperkinesia, careful observations were made on the animal's behavior, and the action of certain pharmacological agents (chlorpromazine, metamizil, methyldiphacil), injected subcutaneously, was investigated. Later, to determine the role of the motor cortex in the mechanism of the head nodding movements, this area of the cortex was extirpated bilaterally.

At the conclusion of these investigations, the dog's brain was examined histologically. Considerable destruction and secondary degeneration of the neural elements were observed in the region of the medial group of nuclei of the thalamus—the medial dorsal, the central lateral, and the parafascicular nuclei—and also

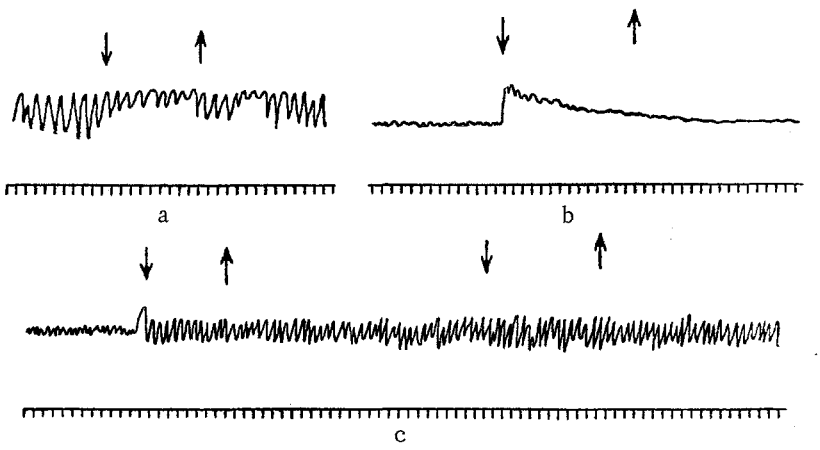

Fig. 2. Recordings of the rhythmic nodding movements of the dog's head. a) Before injection of metamizil; b) at the 5th min after injection in a dose of 0.65 mg/kg; c) on the 2nd day after bilateral extirpation of the motor cortex. ↓) Buzzer switched on; ↑) switched off. Below) time marker (1 mark per sec).

the habenular nucleus, with secondary degeneration of the neural elements and their replacement by neuroglia in the formations of the subthalamic region, the hypothalamic nucleus, the posterior part of the lateral nucleus, the nucleus of the habenulo-peduncular tract, and the interstitial nucleus of Cajal. A morphological analysis of the cortex after extirpation revealed absence of the anterior and posterior sigmoid gyri and of the coronary gyrus in the right hemisphere and absence of the anterior and posterior sigmoid gyri and injury to the proreal (Fig. 1).

The nodding movements of the head were recorded kymographically.

EXPERIMENTAL RESULTS

The hyperkinesia of the dog's head diminished only when the animal became drowsy and ceased in deep sleep. A strong extraneous stimulus, attracting the dog's attention, temporarily weakened the nodding (Fig. 2a).

Chlorpromazine, in doses of 0.1 and 0.3 mg/kg, reduced the amplitude of the nodding movements, whereas in large doses (0.5 and 2.5 mg/kg) it led to their total cessation 13-15 min after its administration; in these circumstances the animal fell asleep, the muscle tone became greatly relaxed, and the head fell to the side. After 20-30 min, the nodding of the head was resumed, and after 2 h it had regained its usual amplitude. The sound of a buzzer, against the background of the action of small doses of chlorpromazine, caused an increase in the amplitude of the nodding, while against the background of the action of large doses it only caused the head to turn towards the side of the stimulus.

The action of metamizil was investigated after injection in doses of 0.5 and 0.65 mg/kg. In a dose of 0.5 mg/kg, this drug abolished the hyperkinesia after 18 min, and in a dose of 0.65 mg/kg—after 5 min. Disappearance of the nodding of the head during the action of metamizil was observed for 30-40 min. The action of the buzzer in these circumstances evoked a reaction of turning the head to the side of the stimulus and the appearance of weak nodding movements after a short time (Fig. 2b). It should be noted that, unlike chlorpromazine, metamizil did not make the animal sleepy.

Methyldiphacil was injected in doses of 1.3 and 6.5 mg/kg. In a dose of 1.3 mg/kg, the preparation caused only a very slight decrease in the amplitude of the nodding movements, whereas in a dose of 6.5 mg/kg it abolished the hyperkinesia and the animal thereupon fell asleep.

On March 25, 1964, bilateral extirpation of the motor cortex was performed on the dog, but did not lead to disappearance of the hyperkinesia. When placed in a cradle during the experiment the animal fell asleep, and relaxation of the hyperkinesia was observed. During the action of the buzzer the dog awoke, and the signs of hyperkinesia increased sharply (Fig. 2c).

The results of the pharmacological investigations showed that all the drugs used, which act mainly on the subcortical formations [1, 4], stopped the nodding movements of the head. It may therefore be postulated that the observed hyperkinesia was based on changes taking place in the subcortical formations. The fact that bilateral removal of the motor cortex did not lead to disappearance of the hyperkinesis confirmed this hypothesis, and the results of the histological analysis demonstrated that the pathological focus responsible for the observed motor disturbances was situated in the thalamus.

The fact that constant rhythmic nodding movements of the head appeared on the 13th day after removal of deep electrodes from the brain (the time of formation of scar tissue in the brain) is of particular interest to clinicians using the methods of implantation of electrodes into the brain for the treatment of certain diseases in man.

The results obtained thus confirm the importance of certain subcortical formations in the mechanism of motor disturbances resembling clonic convulsions in character.

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