PARTICIPATION OF THE RETICULAR FORMATION OF THE PONS IN THE REGULATION OF BLOOD CLOTTING

G. A. Yakunin

Research Institute of Physical Education and School Hygiene
(Director, Corresponding Member APN RSFSR Dr. Biol. Sci. A. A. Markosyan), Moscow
(Presented by Active Member AMN SSSR V. V. Parin)
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Previous investigations [1, 2, 3] revealed differences in the influence of the various segments of the recticular formation of the hypothalamic region on the coagulation of the blood. Continuing these investigations, we studied the influence of the reticular formation of the pons on the blood clotting time, the concentration of factor V, the prothrombin and heparin levels in the blood of the rabbit. The electrical activity of the cerebral cortex and reticular formation was compared with the dynamics of the blood clotting indices studied. No information on this subject could be found in the literature.

EXPERIMENTAL METHODS

Experiments were conducted on unanesthetized rabbits with bipolar electrodes (30-70 μ) implanted in the cerebral cortex and in the reticular formation on the pons. The Sitkovskii-Egorov apparatus was used to measure the blood clotting time. The concentration of factor V was determined by the method of Lewis and Weir, the prothrombin concentration by Quick's method, and heparin by the protamine sulfate titer. The electrical activity was recorded on a four-channel ink-writing electroencephalograph. At the beginning of the experiment the initial electrical activity was recorded and the initial values of the clotting time of the blood and the concentrations of factor V, prothrombin, and heparin were determined. This was followed by a short-period (10 sec) of local electrical stimulation with rectangular pulses with a voltage of 2-3 V. The changes in electrical activity were examined until restoration of the normal EEG and of the normal levels of the blood clotting indices.

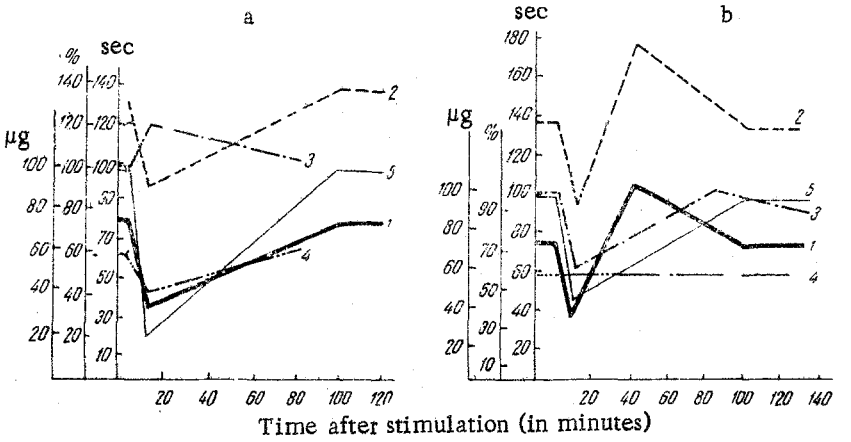

Fig. 1. Changes in the blood clotting time and concentration of factor V, prothrombin, and heparin after electrical stimulation of the rostral and caudal parts of the reticular formation of the pons (a) and the middle part of this structure (b). The arrows denote the time of stimulation; details of curves: 1) beginning; 2) end of blood clotting; 3) prothrombin; 4) heparin; 5) factor V.

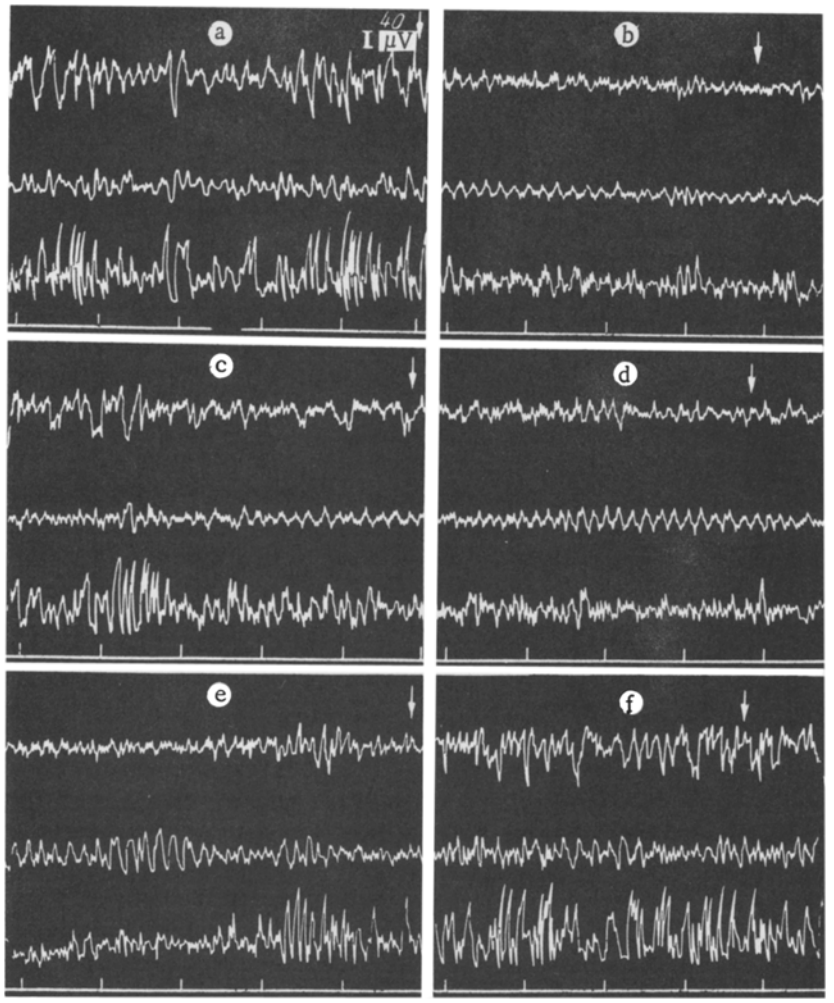

Fig. 2. Changes in the electrical activity of the cortex and reticular formation during stimulation of the caudal part of the reticular formation of the pons with an electric current. Significance of curves (from top to bottom): reticular formation of hypothalamus, reticular formation of pons, motor cortex; time marker (1 sec): a) electrical activity before stimulation; b) 3 min; c) 8 min; d) 15 min; e) 45 min; f) 1.5 h after stimulation. Arrow indicates moment of taking blood.

Blood for analysis was taken from the auricular veins before and at intervals of 10 sec, 5, 10 min, and so on after stimulation until the normal level of the blood clotting indices had been restored. In some experiments the respiratory movements were recorded by means of an pneumographic attachment. After the experiments the position of the electrodes in the brain structures was verified histologically.

EXPERIMENTAL RESULTS

Local stimulation of the various regions of the reticular formation of the pons caused changes of different character in the coagulation of the blood and the electrical activity of the brain. During stimulation of the rostral and caudal parts of the reticular formation of the pons the blood clotting time was shortened, the prothrombin level raised, and the concentrations of factor V and heparin in the blood lowered (Fig. 1a).

Stimulation of the middle part of the reticular formation of the pons caused a somewhat different picture of changes in the electrical activity of the brain and the coagulation of the blood. After stimulation a shortening of the clotting time was observed, which was followed by a slowing a sharp decrease in the factor V, a lowering of the prothrombin level, and a very slight increase or no change in the heparin concentration (Fig. 1b).

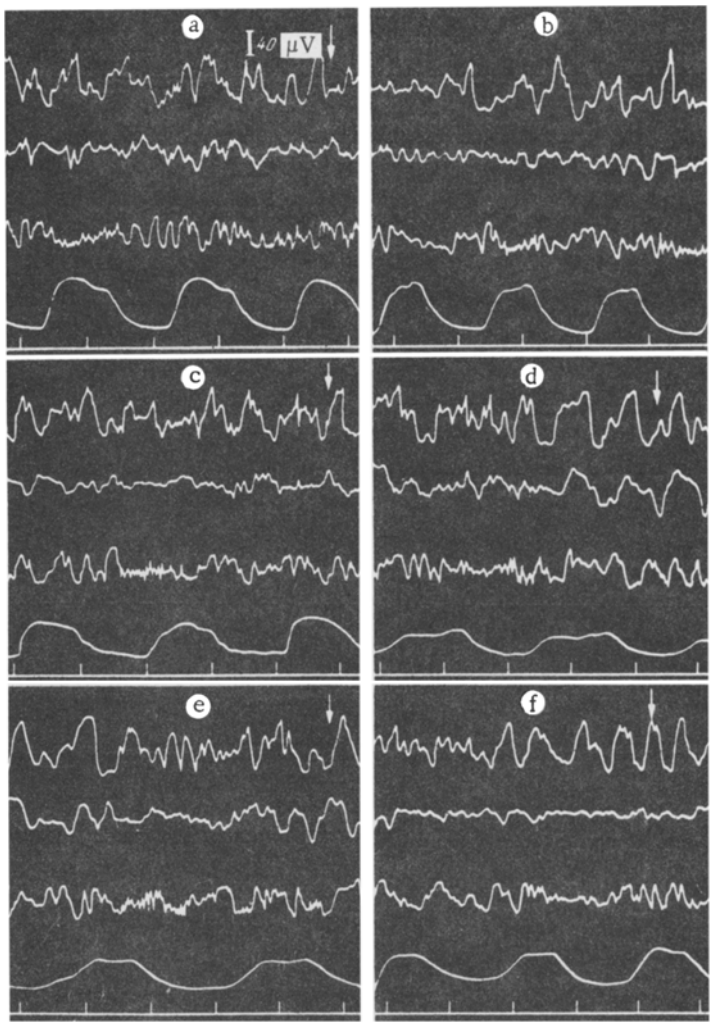

Fig. 3. Changes in the electrical activity of the cortex and reticular formation during stimulation of the middle part of the reticular formation of the pons with an electric current. Significance of curves (from top to bottom): occipital region, reticular formation of pons, right frontal region; respiration; time marker (1 sec): a) initial electrical activity before stimulation; b) 40 sec; c) 10 min; d) 20 min; e) 30 min; f) 40 min after stimulation. Arrow indicates moment of taking blood.

Stimulation of the rostral and caudal parts of the reticular formation of the pons caused, besides acceleration of blood clotting, stimulation of respiration and a well marked arousal reaction (Fig. 2). Whereas the initial value of the clotting time of the blood and the normal blood concentrations of factor V, prothrombin, and heparin before stimulation corresponded to arrhythmic electrical activity of varied amplitude (Fig. 2a), immediately after stimulation of the rostral and caudal parts of the reticular formation of the pons, on the other hand, a uniform and regular rhythm appeared in these areas with a frequency of 4-7/sec, while in the motor cortex desynchronization developed or a rhythm of almost uniform amplitude and a frequency of 4-7/sec appeared. Restoration of the electrical activity began 7-20 min after stimulation and was complete after 1 h or slightly sooner. Normal electrical activity was restored sooner and more clearly in the cortex than in the reticular formation of the pons (Fig. 2b, c, d, e, f). Normalization of the EEG preceded restoration of the normal blood clotting time.

After stimulation of the middle part of the reticular formation of the pons at first a very slight fall in the amplitude of the waves was observed (Fig. 3b). The respiration was deepened at the moment of expiration (Fig. 3b).

After stimulation of the middle part of the reticular formation of the pons at first a very slight fall in the amplitude of the waves was observed (Fig. 3b). The respiration wsa deepened at the moment of expiration (Fig. 3b). After 5-10 min an increase in the amplitude of the slow waves was observed on the EEG, and slowing and a reduction in the depth of the resporatory movements on the pneumogram (Fig. 3d, e). The increase in the amplitude and duration of the slow waves was accompanied by prolongation of the blood clotting time and a decrease in the concentration of prothrombin and factor V in the blood. The increase in the amplitude and duration of the slow waves in the cortex and in the middle part of the reticular formation of the pons probably indicates the spread of the inhibitory process in these structures.

Our experimental results demonstrate the functional heterogeneity of the structures of the reticular formation in the pons. It may be postulated that during stimulation of the rostral and caudal parts of the reticular formation of the pons the adrenergic substrate of this formation [6] is excited and the descending activating influences are stimulated, but stimulation of the middle parts of the pons causes stimulation of the descending inhibitory influences and only partial excitation of individual cells of the adrenergic system. This is the probable explanation of the transient shortening of the clotting time of the blood.

Our earlier investigations [3] showed that the primary integration of the processes taking part in blood clotting evidently occurs in the diencephalic end of the reticular formation. Direct influences brought to bear on the hypothalamic region lead to the appearance of impulses in that region which affect the cells of the inferior pattern of the reticular formation of the brain stem and spinal cord [2].

Hence, the activity of these neurons of the reticular formation of the pons is subjected to the influence of the descending systems of the diencephalic portion of this formation. At the same time, the diencephalic part of the reticular formation is under the tonic control of the caudal divisions of the brain stem. In the region of the reticular formation of the pons at the level of the abducent nerve neurons are situated which possess long, ascending axons, feeding information back to the hypothalamic region and the cerebral cortex [5, 7].

Apparently the reticular formation of the brain stem is the structure responsible for the wide interaction of various influences on the autonomic functions, by virtue of the large number of interconnections between its different regions.

SUMMARY

In unanesthetized rabbits with electrodes implanted into the cerebral cortex and into the reticular formation of pons varolii a study was made of the effect produced by the stimulation of the reticular formation of pons varolii on the electric activity of these portions of the brain, blood coagulation time and of the factor V, prothrombin and heparin content in the blood.

Following stimulation of the rostral and caudal portions of the reticular formation of pons varolii – blood coagulation was accelerated, prothrombin level increased, whereas factor V and heparin concentrations dropped. With the same stimulation of the medial, portion of the pons Varolii reticular formation there sets in, at first, a transitory acceleration of blood coagulation which is then followed by its deceleration and the reduction of factor V and prothrombin blood content. The EEG "activation reaction" is mostly accompanied by acceleration of blood coagulation, whereas an increase of the slow oscillations amplitude and the acceleration of "spindle" bursts – by its deceleration. The EEG normalizes earlier than the initial blood coagulation time does.

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