feature) per 100 erythrocytes. Exovesiculation affected not only the outer layer, as in the control, but also the inner layer of the cytolemma. These changes were observed particularly often in poikilocytes and schizocytes, but they were also commonly found in the stomatocytes and echinocytes, although they were hardly ever observed in the control animals. In all transformed erythrocytes fusion of hemoglobin granules was observed mainly in the central zones; the width of these areas was increased to 1.5-3 times that in the control (Fig. 2). The number of erythrocytes with signs of hemolysis (erythrocyte "ghosts"; Fig. 3) was doubled.

Sensitization of albino rats with NHS is thus reflected in the state not only of leukocytic, but also of erythrocytic hematopoiesis. Changes in the shape and ultrastructure of the erythrocytes under these circumstances, amounting in some cases to injury and destruction, are evidence that they participate in the immune response of the body to antigenic stimulation by foreign protein as target cells [1, 7].

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ADVANTAGES OF ULTRASONIC SURGICAL INSTRUMENTS FOR USE IN EXPERIMENTAL NEUROPHYSIOLOGY

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The use of ultrasonic instruments (USI) in neurosurgery, ophthalmology, otorhinolaryngology, traumatology, and other branches of medicine is increasing at the present time. This is because of some important advantages of the method, and in particular, the reduction of tissue trauma and the hemostatic effect. The wide use of this type of energy to divide biological tissues has become possible with the introduction of resonance rods of variable section, allowing concentration of oscillatory movements (from 23,000 to 60,000/sec, with an amplitude of up to 100 μ or more) on the cutting edge of the surgical instrument. Physiological tolerance of the brain to the action of USI has been determined experimentally [1, 4-6]. In this connection existing types of instruments are being improved and new ones created [2, 3], and the scope for their use in neurosurgery is being widened.

The aim of this investigation was an experimental study of the effect of ultrasonic techniques on the functional state of the brain and its individual structure in order to determine the most appropriate and least traumatic method of removal of certain brain structures chosen for study.

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EXPERIMENTAL METHOD

An experimental ultrasonic neurosurgical apparatus, developed by the Department of Neurosurgery, Central Postgraduate Medical Institute, jointly with the Acoustic Institute of the Academy of Sciences of the USSR was used for these purposes. The instrument is based on an ultrasonic oscillating system (at a frequency of 44 ± 10 kHz), consisting of an electromechanical ferrite transducer and a transformer of mechanical oscillations fixed firmly to it. The final stage of the transformer was made in the form of a surgical instrument (scalpel, raspatory, disintegrator, and so on). The amplitude of oscillations of the cutting edge was up to 50-70 μ. The ultrasonic aspirator consisted of a magnetostriction electromechanical transducer, loaded on a two-stage resonance transformer, made in the form of a hollow tube of variable cross-section from titanium alloys. The cutting edge, performing longitudinal oscillations with an amplitude of 35 to 50 μ is formed at the entrance to the tube. The aspiration system, with a vacuum of 0.2-0.6 kg/cm^2, which is sufficient for the removal of tissues, including neoplasms. The instrument is switched on and off by means of a foot pedal. It is connected to the generator by means of a thin electric cable, which does not restrict the surgeon's movements.

In the course of the investigation 33 acute experiments were conducted on 11 cats, anesthesized with chloralose (80 mg/kg). The animals were placed in a stereotaxic apparatus and the cerebral cortex of both hemispheres was exposed (to prevent the surface of the cortex from drying it was periodically irrigated with warm mineral oil). Evoked potentials (EP) in response to contralateral peripheral stimuli (flashes and stimulation of the radial nerve by discharges of current (10 V, 0.5 msec) were recorded and averaged on the APT-1000 computer.

The cortical projection area VI was destroyed by ultrasonic disintegration or by thermocoagulation. EP were recorded actually during the procedure (30 sec) and for 90 sec thereafter. The recording electrodes were placed in the immediate vicinity of the region of injury, in area VII adjacent to it in the parietal region, and also in a subcortical structure, namely the lateral geniculate body (LGB), a specific visual nucleus of the thalamus.

Damage to the visual cortex, destruction of the cerebellum, and stimulation of the brain stem were carried out by ultrasound. EP were recorded to contralateral somatic stimuli in projection area S1 and in the ventral posterolateral thalamic nucleus, a specific somatic nucleus (VPL). To determine the more precise functional state of the cerebral cortex the method of paired stimuli also was used.

EXPERIMENTAL RESULTS

Ultrasonic destruction of brain tissue and injury by thermocoagulation induced qualitatively different changes in EP in the cortical and deep brain structures investigated. During destruction of zone VI (area 17) and the adjacent zone VII (area 18), and also in the parietal cortex and the subcortical nucleus LGB, EP similar in the magnitude of their parameters to those recorded initially were recorded after 30 and 90 sec. After extirpation of the same zone by thermocoagulation evoked responses in the test structures showed even greater disturbances. After 90 sec their amplitude still remained low (2.5-3 times) and disappearance of their secondary components was observed.

In the next series of experiments the time course of EP to somatic stimuli was studied in the primary projection zone S1 and also in the specific thalamic nucleus (VPL) during the ultrasonic operation on the brain stem and cerebellum (the cerebellum was destroyed by a method similar to that of neurosurgical operations on the patient). It was found that during ultrasonic destruction of the cerebellum the evoked responses in S1 and VPL showed no significant change. No change likewise was observed during the procedure with USI on the brain stem.

The method of paired stimuli was used for a more detailed analysis of the functional state of the cerebral cortex in the case of cortical injury. Evoked responses in regions of the cortex directly adjacent to the extirpated region were recorded in two series of experiments: with exposure to ultrasound (Fig. 1a, b) and with extirpation (Fig. 1c, d). The investigations showed that the amplitude of the testing potential during exposure to ultrasound, even close to the site of injury, showed no significant changes, whereas in the second case (extirpation) the amplitudes of the potentials were considerably reduced (by 1.5-2 times) and their latent period was lengthened.

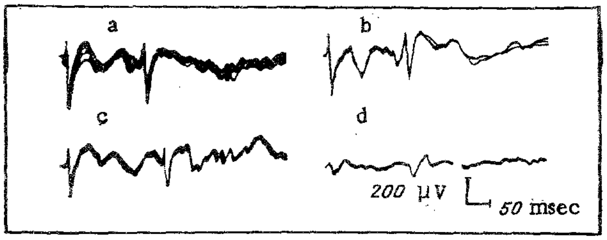

Fig. 1. Evoked responses to paired stimuli in cortical regions immediately adjacent to zone of injury. a, b) Ultrasonic injury (a — before, b — after injury); c, d) mechanical extirpation (c — before, d — after extirpation).

The morphological investigation also revealed a smaller zone of injury to the neurons and surrounding glia in the case of the ultrasonic operation.

The proposed method can thus be used to extirpate zones of the cerebral cortex with least trauma to surrounding tissue, so that the physiological effects of removal of a test region can be studied more adequately. As a result of these investigations this method can be recommended not only under experimental conditions, but also for clinical use, especially in neurosurgical practice.

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