THE INFLUENCE OF AN ULTRA-HIGH FREQUENCY ELECTROMAGNETIC FIELD ON THE ELECTRICAL ACTIVITY OF AN ISOLATED STRIP OF CEREBRAL CORTEX

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As we have shown previously [8] a preparation of an isolated brain including the diencephalon and cerebral hemispheres undergoes a change in electrical activity under the influence of an ultra-high frequency (UHF) field. In the present article we consider the part played by the cerebral hemispheres in this response. We have used the method of neuronal isolation of a strip of cerebral cortex (subsequently referred to simply as a strip).

Although until recently the problem of the innate electrical activity of a strip has not been explained it is known that potentials arise in it in response to electrical or chemical stimulation [1, 10, 12]. The object of the investigation was to study the response of a strip of rabbit cortex to the action of an UHF field.

EXPERIMENTAL METHOD

The size of the strip was determined by what was most convenient and by the area of the sensory motor cortex which could be isolated without blood loss. We therefore isolated an area measuring 5 · 15 mm and 5-8 mm deep; we used a U-shaped loop of steel wire of diameter 0.4 mm. A copper wire 10 cm long and 4 mm in diameter was fixed perpendicular to the plane of the loop. The operation to isolate the strip proceeded as follows. The skin of the upper part of the skull of an unanesthetized animal was removed. A trepan was then used to reveal the anterior half of one cerebral hemisphere. An incision was then made through the dura mater in the region of the olfactory lobe of one hemisphere, and its depth was extended to 3-5 mm. Into this slit the front end of the loop was introduced and was gradually pressed into the horizontal position as it was moved over the whole length towards the back of the brain. Then the loop beneath the cortex was moved parallel to the surface of the brain, raised up vertically to the pia mater and by use of a finger it was pressed up against the dura mater along the whole of its length. It could be

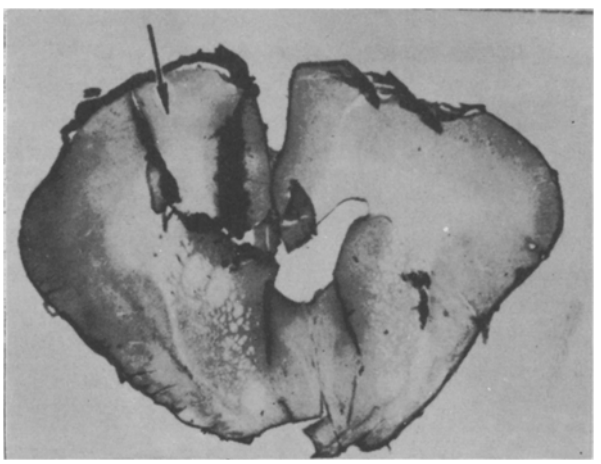

Fig. 1. Transverse section of the brain of a rabbit. The arrow indicates the neuronally isolated strip of cortex.

seen through the dura that the loop had completely isolated the strip of cortex within it. The same manipulation was then carried out in the reverse sequence in order to withdraw the loop. In this way the loop twice passed through the same path, effectively isolating a strip of cortex. The completion of the isolation was confirmed histologically (Fig. 1). A similar method of isolation of a strip was used in other cortical areas.

Potentials from the strip were led off by means of bipolar electrodes; the electrodes were of copper and to their ends were attached cotton wicks moistened in physiological saline. At the same time the same method was used to record the electrical activity from the portion of cerebral cortex situated in the symmetrically opposite position, and sometimes records were made also of other regions of the damaged hemisphere. The electrocorticogram was recorded by a method we have described previously [8].

EXPERIMENTAL RESULTS

Electrical recording began 10-20 min after the operation and were continued at various time intervals for 4-6 h during the day of operation, and in some cases on subsequent days. For the first 20-100 min after the operation the strip of cortex was "silent." Later high-amplitude spike potentials were recorded; at first they occurred only occasionally (at 20-sec intervals); then the frequency gradually increased, until the spikes occurred every two seconds. The electrical activity ceased 3-6 h after the operation or else fell below the level of the activity of the surrounding areas. On the day after the operation in all cases there was little difference between the activities of the strip and of the surrounding cortex.

We applied an UHF field to the head of the rabbit 10-20 min after isolation of the strip. Each application lasted 2-3 min, and was repeated after 20-40 min. The response was extremely stable (occurred in a high percentage of the cases) and the latent period was moderate. The experiments were carried out on 40 rabbits in which a strip of cortex had been isolated either in the frontal or in the occipital region, or sometimes in the frontal and occipital region of one or of two hemispheres. The main series of experiments was carried out on 16 rabbits having an isolated strip in the frontal region.

The reaction of the strip to an UHF field differed from the reaction of the intact cortex. In 63% of the cases there was an over-all increase of electrical activity; spike potentials appeared during spasmodic discharges (Fig. 2 A), and in 23% of the cases the electrical activity was reduced (Fig. 2 B). In 14% of the cases the effect on the strip was to produce regular waves of frequency 1-3 cycles (Fig. 2 C).

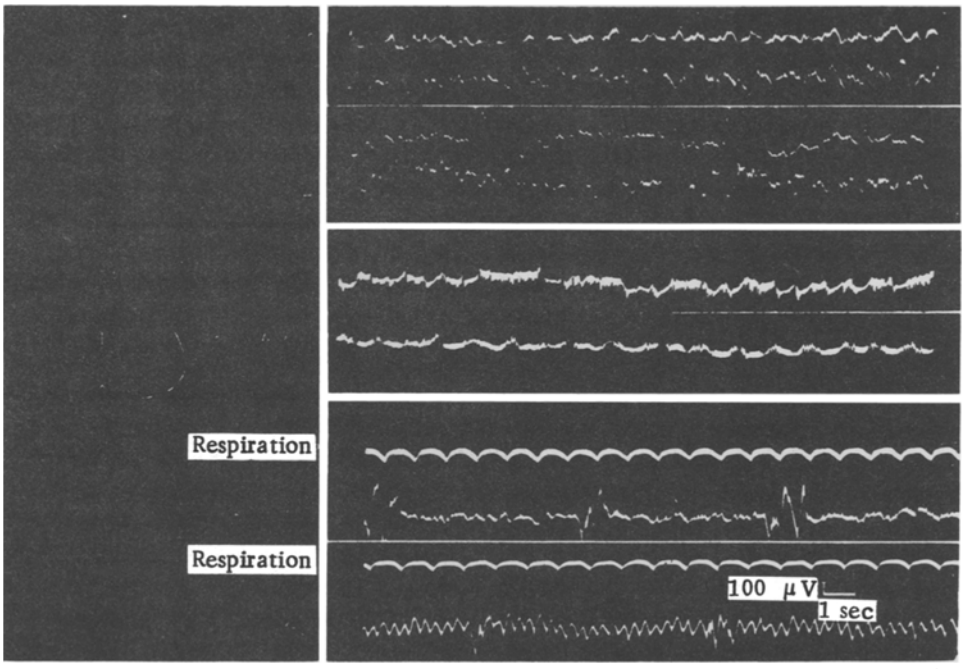

Fig. 2. Electrical activity of a neuronally isolated strip of cortex (1-2) of a rabbit (I) before and (II) during the action of an UHF field. During the action of the field the electrical activity increases by an amount dependent upon its original level (A), but the electrocorticogram of the intact hemisphere shows no alteration (3-4), or is reduced (B), or becomes rhythmical (C), independently of the respiration.

TABLE 1. Comparison of the Response of the Intact Brain, Isolated Brain, and Strip of Cerebral Cortex to a UHF Field

Object investigated	No. of animals	No. of actions	No. of reactions	Stability (in %)	Mean latent period (in sec)
Intact brain . .	12	67	30	45	53
Isolated brain.	8	57	26	45	34
Strip	16	98	51	52	27

It is important to note that the isolated strip was in the frontal region, and the EEG of the intact and isolated brain was recorded from the occipital or parietal region. However, it is justifiable to compare the results obtained on the intact brain, the isolated brain, and of the strip, because in a separate series of experiments it was shown that the frontal and occipital strips respond to the UHF field in a similar way. For example, in experiments on 13 rabbits (7 with frontal and 6 with occipital strips) it was shown that the stability of the response to the UHF field was 55% for the frontal strip, and 50% for the occipital strip. The mean latent periods for the responses were 24 and 26 sec, respectively.

As Fig. 1 shows the stability of the reaction of the strip was somewhat greater and the latent period somewhat shorter than the corresponding quantities for the intact isolated brain. Therefore the strip was more sensitive to the UHF field. A feature of the strip was that in some cases the response occurred only after the action of the field had ceased. The effect elicited by cessation of the field was of the same form and had the same latent period as the response at onset.

On the day on which the isolation was carried out the response of the strip depended upon the time elapsing after operation. Approximately three hours after the strip had been isolated the stability of the response of the strip to the UHF field rose from 46 to 60-100%. However, in long-term experiments (2-10 days after isolation) the strip was less sensitive to the UHF field than it was during the first hours after the operation.

If we compare the stability of the response of the strip in different rabbits it can be seen that this index varies from 25 to 90% (as compared with a variation of the intact brain of from 25 to 75%). Thus, isolation of the strip does not prevent the appearance of individual variations of the response to the UHF field.

In an analysis of the latent period of the reactions of the different parts it must be remembered that the mean value does not constitute the whole index. Therefore, as in previous communications [8] we have made a further comparison by studying the qualitative distribution of the different groups of reactions in terms of their latent periods.

As Table 2 shows, in comparison with the intact or the isolated brain the strip shows a preponderance of reactions with a short latent period. We may therefore suppose that reactions having a latent period of from 1 to 25 sec with a maximum at 15 sec are purely cortical. We must also add that the reaction of the strip was less well marked at later times (1-5 min) than was that of the intact brain (15-20 min).

Many studies have demonstrated the action of UHF, or super high-frequency (SHF) fields on the brain. It has been shown that after unilateral irradiation of rabbits with a SHF field the EEG on the irradiated side changes more than on the opposite side [2]. The action of a SHF field also alters the structure of the cortical cells [6]. The UHF and SHF fields influence conditioned-reflex activity of dogs [3, 5].

If we admit that there is a direct action of UHF field on the cortex we may then suppose it is not produced by the neurones, whose response time is a fraction of a second, but that it is the more inert glial cortical cells which respond [11]. However, as experiments with a neuronally isolated strip of cortex have shown, the possibility remains that there is a secondary (probably humoral) influence exerted on the strip by the subcortex, which may perhaps be the first to respond to the electromagnetic field [4, 9]. Important evidence could be brought to bear on this point by an experimental study of the influence of an electromagnetic field on a culture of isolated nervous tissue.

TABLE 2. Relationship of the Different Groups of Reactions of the Intact Brain, the Isolated Brain, or the Strip to an UHF Field

Object investigated	Number of reactions (in %) having a latent period of		
	1-25 sec	26-65 sec	86-115 sec
Intact brain	0	82	18
Isolated brain.	34	66	0
Strip	55	34	11

SUMMARY

A neuronally isolated strip of cerebral cortex in a nonanesthetized rabbit was shown to change its electrical activity after application of a UHF field of 1,000 v/m to the head . The reaction of the strip to the UHF field occurred in 52% of the cases and was usually shown by an increased amplitude of the potentials. At times, however, the electrical activity was reduced, or irregular waves having a frequency of 1-3

cycles per second appeared. The nature of the response of the strip was not a function of its position in the brain. The latent period of the reaction of the strip was on average 27 sec, and the after effect lasted 1-5 min; both these times were shorter than the corresponding times for the response of the intact brain to UHF radiation.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. ***Some or all of this periodical literature may well be available in English translation.*** **A complete list of the cover-to-cover English translations appears at the back of this issue.**
