INFLUENCE OF AN ULTRAHIGH-FREQUENCY (UHF) ELECTROMAGNETIC FIELD ON THE TEMPERATURE IN RABBIT FEMORAL TISSUES

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The thermal effect of UHF energy on the tissues of the organism has been studied chiefly in the case of a single influence [6, 7]. As a result of these investigations, the changes in the temperature of the tissues under the influence of UHF electromagnetic energy have been sufficiently fully qualified. However, very often, especially in therapeutic practice, various portions of the body are subjected to repeated influences of thermal doses of UHF radiations [1, 3, 5].

The purpose of our investigations was to cast light on the changes in the temperature in the tissues of the organism under repeated local influences of UHF radiations.

EXPERIMENTAL PROCEDURE

The experiments were conducted on 10 rabbits, which were irradiated with the LUCh-58 apparatus for UHF therapy ($\lambda = 12.6$ cm). The temperature of the femoral tissues was measured at various depths with specially designed thermocouples [2]. The tissue was treated under conditions of normal circulation and innervation, as well as in the case of denervation and a disruption of blood circulation. The animals were accustomed to the setup of the experiment in order to eliminate thermodynamic changes as a result of their restraint. The blood circulation was disrupted by placing a tourniquet on the femur. The nerves of the hind leg were cut according to the usual procedure; in addition, various portions of the central nervous system were disconnected by spinal anesthesia and ether narcosis. Parameters of irradiation: power flux density 150 watts/cm^2, duration of the influence 10 min (the power flux density was measured by V. V. Sevast'yanov). The intervals between irradiations were 3, 4, and 24 h.

EXPERIMENTAL RESULTS

In the case of a single irradiation of the rabbit femur, the temperature in the muscles at a depth of 2 cm was increased by 3.12 ± 0.08°. The skin surface was heated less (by 2.24 ± 0.12°). The maximum heating (3.42 ± 0.06°) was registered at a depth of 0.5 cm. After irradiation was stopped, the temperature fell comparatively slowly and reached the initial level on the average after 1.5 h.

In the case of repeated irradiations of the same femur at 24-h intervals, the degree of increase in the temperature of the tissues was reduced (Table 1).

From the data of Table 1, it is evident that in the case of comparatively short intervals between sessions of irradiation, as the number of sessions is increased, the temperature effect increases. This effect is not the result of a simple summation of the temperature changes in the tissues caused by the preceding and following irradiation, since the temperature of the tissues decreases to the initial level considerably before the following session of influence of UHF energy. The cumulative process in this case is evidently based upon neuroreflex phenomena, mani-

TABLE 1. Changes in the Degree of Heating of the Femoral Muscles after Repeated UHF Irradiations with Various Intervals between Sessions of Irradiation

Interval between irradiations (in h)	No. of rabbits	Increase in temperature in muscles at a depth of 2 cm (in degrees)				
		first irradiation	third irradiation	fifth irradiation	tenth irradiation	fifteenth irradiation
24	10	3.18 ± 0.09	2.54 ± 0.07	1.64 ± 0.1	1.73 ± 0.06	1.58 ± 0.07
3	10	3.28 ± 0.07	3.68 ± 0.09	4.12 ± 0.1	–	–
4	10	3.24 ± 0.06	3.54 ± 0.08	–	–	–

TABLE 2. Changes in the Degree of Heating of Femoral Muscles with Impaired Blood Circulation and after Denervation of the Limb (PPM-150 n. /cm^2)

Experimental conditions	Interval between irradiation	No. of rabbits	Temperature rise in muscles at a depth of 2 cm (in degrees)		
			first irradiation	fifth irradiation	tenth irradiation
Impairment of blood circulation	24	10	4.12 ± 0.09	3.21 ± 0.06	2.72 ± 0.08
Denervation of limb	24	10	2.72 ± 0.08	2.94 ± 0.06	3.12 ± 0.07

Note. In experiments with impaired blood circulation, exposure 5 min; experiments with denervation of limb 10 min.

fested in tracking reactions in the central nervous system. Thus, irradiation of the femur of a rabbit with disconnection of various portions of the central nervous system (by the method of spinal anesthesia and ether narcosis) entirely removed the cumulative effect. When the irradiation intensity was increased to 300 mW/cm^2 (exposure 10 min), a large increase in the temperature was observed (an average of 6° at a depth of 2 cm); in this case, the temperature of the femoral tissues reached 44° or more. Repeated irradiations produced an even greater temperature rise. Thus, after the fifth influence it was an average of 8-9°. It may be that sufficiently intense irradiation, which is a strong irritant, may lead to a disturbance of the normal adaptive processes in the organism, primarily to a disturbance of thermal regulation.

Irradiation of the femur with blood circulation disconnected sharply increased the heating of the tissues, especially those situated beneath the skin. Thus, the increase in the temperature at a depth of 2 cm was 10.28 ± 0.09°. As the number of irradiation sessions was increased, the temperature rise increased, which led to gross morphological changes in the tissues, all the way up to necrosis (in seven rabbits out of ten, extensive muscle necrosis appeared after the third irradiation). Consequently, the blood circulation plays an important role in the adaptation of the organism to the local influences of UHF electromagnetic radiations. When the duration of irradiation was reduced to 5 min, the rise in the temperature of the femoral tissues was tripled on the average. As the number of irradiations was increased, adaptive reactions were also manifested under these conditions, being expressed in a decrease in the temperature effect in the subsequent influences. However, this adaptation was less pronounced than in the case of normal blood circulation in the limb (Table 2). Denervation of the irradiated limb, as well as spinal anesthesia and ether narcosis, entirely eliminated the adaptive effects (see Table 2).

As can be seen from Table 2, the temperature rise in the first and subsequent irradiations does not change significantly under conditions of denervation of the limb. Analyzing the results obtained, we may conclude that depending on the conditions (PPM, intervals between influences, state of blood circulation and inervation), either adaptive reactions may develop (adaptation) in the deep tissues under the influence of UHF energy, or an increase in the heating may occur (cumulation). Our data agree with the results of investigations of the adaptation of the organism to total irradiation in UHF fields.

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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.**
