DYNAMICS OF IMPEDANCE OF THE AREA OF TISSUE BETWEEN THE ACTIVE ELECTROMYOGRAPHIC ELECTRODES DURING VESTIBULAR STRESS

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A short time after the beginning of vestibular stimulation by radial acceleration without appreciable muscular contraction a temporary but intensive increase in the initial level of the tissue impedance of the skin is observed.

Radial acceleration accompanies any change in the position of the human head and trunk as they rotate simultaneously [2, 9, 10]. The responses arising under these circumstances may lead to the development of severe autonomic discomfort and to the onset of the symptom-complex of motion sickness [7, 11].

From the results of the writer's impedance-dermatometric (IDM) investigations of the autonomic functions of the skin during skeletal muscular fatigue (the IDM fatigue effect [3]) it was suggested that similar changes arise in the impedance level Z_{AB} in the area of tissue between active electrodes A and B and during the development of vestibuloautonomic responses.

EXPERIMENTAL METHOD

Experiments were carried out under normal environmental conditions on 26 clinically healthy males aged 18-35 years (29 experiments). The choice of area to be tested, the conditions of local treatment of the skin, and the time of beginning of the test were described previously [3]. A Barany's [8] vestibulometric chair fitted with an electric cable [4] was used. Continuous recordings of Z_{AB} (parameters of the sinusoidal testing stimuli: 20 Hz, 10-50 nA) and the electromyogram (EMG) during rotation were made by means of a collector, by fixing to the chair the extension part of the 5-channel complex of a biopotential amplifier for measuring the level of impedance of the skin tissues [3].*

EXPERIMENTAL RESULTS

Soon after the beginning of exposure to extremal radial acceleration without any appreciable muscular contraction (EMG control) a temporary but intensive increase in the initial level of Z_{AB} – the IDM motion sickness effect – was observed (Fig. 1).†

The phenomenon recorded was characterized by the following features. The level of Z_{AB} was considerably increased, and the initial level of the impedance could be increased by 50% or more.

The intensity of the increase in the initial level of Z_{AB} depended on individual predisposition to motion sickness. No IDM motion sickness effect was observed in subjects with a zero degree of vestibuloautonomic

*S. S. Markaryan, I. A. Sidel'nikov, N. I. Grachev, V. I. Zorilé, and G. I. Pavlov also took part in these experiments.

†The absolute values of Z_{AB} are expressed as the corresponding conventional equivalent in the form of active resistance; the high level of Z_{AB} was due to the area of the electrode cups [1] and the topographical differences of impedance [5, 12].

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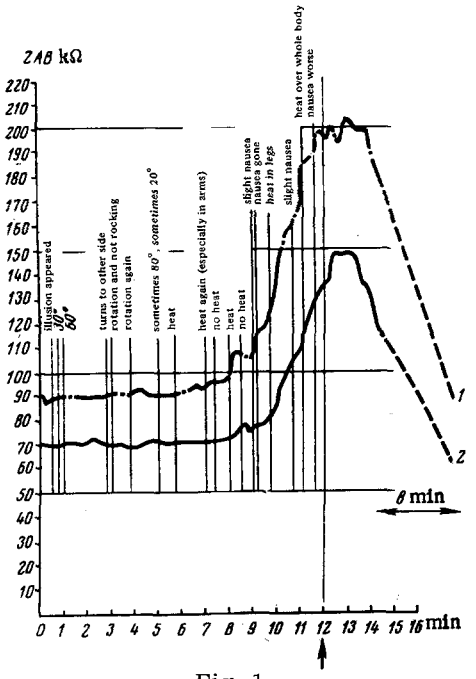

Fig. 1

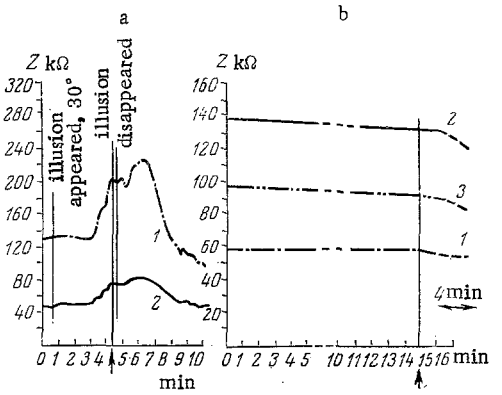

Fig. 2

Fig. 1. Changes in level of impedance Z_{AB} during vestibular stress: 1) right biceps, local rubbing until mild hyperemia appears on the skin over the right biceps; 2) left biceps. Here and in Fig. 2, time of stopping function test indicated by arrow.

Fig. 2. Impedance-dermatograms of persons with different levels of vestibuloautonomic stability: a) vestibuloautonomic reactivity of third degree: 1) local rubbing until mild hyperemia of the skin over the right biceps; 2) until moderate hyperemia of the skin over the left biceps; b) zero degree of vestibuloautonomic reactivity: 1) local rubbing until mild hyperemia of skin over right biceps; 2) over left biceps; 3) over left gastrocnemius muscle.

reactivity [7] (Fig. 2b). Allowing for this latter fact, the confidence limits of the real frequency of manifestation of the IDM motion sickness effect are $P \pm 1.96$, $\sigma_P = 82^{+18}_{-23}\%$ [6].

The character of the subsequent changes of the increased level of Z_{AB} differed after removal of the stimulus. Cessation of motion sickness as a rule is accompanied by short holding of the Z_{AB} level achieved or by its continued growth for a short time (up to 3 min), often with a sharp drop in its level by 5-10% immediately after the cessation of stimulation (Fig. 2a).

In the experiments in which the initial level of Z_{AB} was increased, after the end of vestibular stimulation a more or less gradual decrease (recovery) was observed to the previous value (after 3-15 min, depending on the intensity of the autonomic reflexes), or sometimes a little below it.

The magnitude of the increase in level of Z_{AB} was found to depend on the degree of preliminary cleaning of the skin. If the skin was rubbed excessively ($Z_{AB} \leq$ 1-5 kΩ) no changes were recorded in the level of Z_{AB} during the test. These facts evidently confirm that the observed changes are due to changes in the upper layers of the epidermis.

Experiments using a measuring stimulus of frequency within the range 20-1000 Hz led to qualitatively similar results. The close similarity between the amplitudinal and temporal characteristics of the IDM fatigue effect and the IDM motion sickness effect suggests that they are special forms of a nonspecific stereotyped phenomenon of an increase in the impedance of the skin during exposure to a combined contact environment.

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