EXPERIMENTAL METHODS FOR CLINICAL PRACTICE

Circadian Rhythms of the Electric Potential of the Epidermis in Patients with Essential Hypertension

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The daily time course of the electric potentials of the hand skin and their asymmetry is different in healthy volunteers and patients with essential hypertension. The degree of the epidermis potential asymmetry depends on the time of the day, is determined by the sympathoadrenal activity, and is regulated by the central nervous system.

Key Words: *essential hypertension; sympathoadrenal system; circadian rhythms; electric potential; asymmetry*

Electric polarization, the presence of stable differences of potentials on the skin, and their changes depend on the intensity of metabolic processes and provide information not only about the skin integument, but also on the viscera directly and indirectly influencing the electrodermal activity through nervous and humoral effects [3,6,7,9]. Normal physiological status of an organism is characterized by a certain range of differences in electric potentials (EP), and deviations from the norm may be indicative of abnormalities [1,2,5,7]. The biorhythmological aspect of the problem and the topography of EP are still little studied, although there are good grounds to think that the rhythmic changes in the level and, specifically, asymmetry of epidermal EP during a 24-h and seasonal EP changes are compatible with the changes in electrodermal activity caused by pathological processes [3,8].

In this study we investigated and compared the circadian rhythms of epidermal EP in health and cardiovascular disease.

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MATERIALS AND METHODS

Healthy volunteers (18 men aged 28-55 years, right-sided) and patients with stage II essential hypertension (20 men aged 31-58 years, right-sided) treated at a sanatorium were enrolled in the study. Skin EP were measured by standard nonpolarized EVL electrodes with the following leads: the back and external parts of the hands and the right and left frontal tubers [7]. Arterial pressure, heart rate, and body temperature were monitored in parallel. Coefficients of EP asymmetry (K_{as}), pulsed pressure, Kerdaux vegetative index (KVI), and minute circulation volume (MCV) were calculated. The measurements were carried out 5 times within a 24-h period, starting at 8:00 in various seasons.

RESULTS

A stable left-side asymmetry of EP on the hand skin of normal subjects was revealed. It showed cyclic circadian changes with the acrophase at 16:00. The asymmetry was sometimes as high as 20% of the mean circadian values ($p \leq 0.005$). In the morning and in the evening, the EP K_{as} was close to zero, and in many cases it was inverse (Fig. 1).

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By contrast, in patients with essential hypertension K_{as} was minimal by midday and the acrophase shifted to the evening (Fig. 1). The absolute values of skin EP for both right and left hands were 12% higher ($p \leq 0.001$) than in health, the tendencies of the 24-hour and seasonal time course being the same (r=0.65-0.78). The K_{as} of frontotemporal EP changed from 1 to -12% with the predominance of right-side asymmetry in both groups and a shift of the patients' acrophase to the evening, when the asymmetry values were 16% higher than in normal subjects ($p \leq 0.005$). Arterial and pulse pressure in the patients were 10 and 7% higher, respectively, than in normal controls over the entire follow-up, but in the patients the pulse pressure acrophase was observed earlier, by 12:00, whereas in normal subjects it coincided with the acrophases of EP asymmetry, and MCV and was recorded at 16:00.

Circadian changes in KVI were similar in both groups (r=0.91), being minimal at 16:00; however, the mean values were 57% higher in the patients, indicating stress of the regulation systems [1,2] (Fig. 2). Although seasonal changes in the mean daily values of skin EP on the right and left hands were virtually identical, EP asymmetry varied in different seasons: K_{as} in normal subjects was 30% higher ($p \leq 0.005$) in summer and autumn than in patients and two times lower in winter ($p \leq 0.001$). Seasonal rhythms of EP asymmetry and KVI in the morning hours were asynchronous, as well as the shifts of pulse pressure and MCV acrophases. The maximum pulse pressure was observed in spring in patients and in summer in normal subjects at any time of the day, and the MCV acrophase of healthy volunteers anticipated the MCV acrophase of patients by 2-3 months only in the morning.

Comparison of the data has revealed a similarity between biorhythmological characteristics of physiological and electric parameters in normal volunteers and patients with essential hypertension, suggesting a common mechanism of their formation. The circadian rhythms of circulation and respiration in health are strongly determined by the periods of changes in the sympathoadrenal activity, which are similar in duration [1,2]. Generally, the disturbances of cardiovascular regulation in patients with essential hypertension lead to the development of compensatory reactions [1,2,5]. This manifests itself not only in discordance of the rhythms, shifts of the acrophases of physiological processes, but also in higher levels of the epidermal EP and its specific circadian changes varying in different seasons.

Based on these findings, we have concluded that changes in the sympathoadrenal status are the most probable common mechanism determining rhythmic

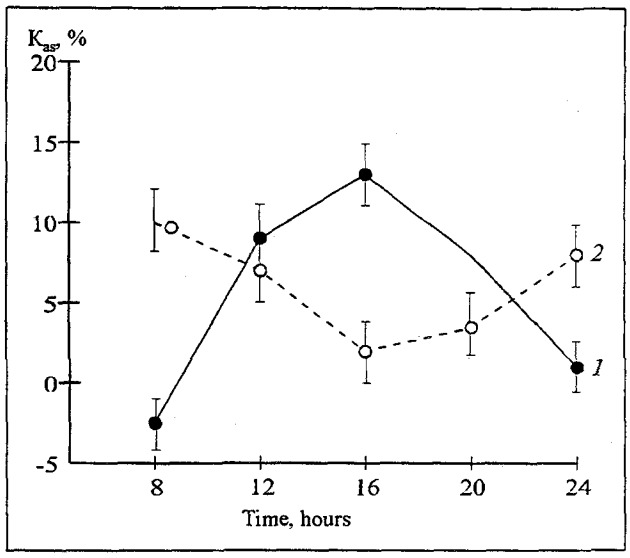

Fig. 1. Circadian changes in the asymmetry coefficient of the skin electric potential in normal subjects (*1*) and patients with essential hypertension (2).

changes in electric and physiological parameters in the patients. This conclusion was confirmed by circadian rhythms of skin EP K_{as} in normal subjects and patients and the relationship between these rhythms and the vegetative balance of the organism. A decrease in the level of electrodermal reactions and even their inversion in subjects prone to arterial hypertension have been reported [5]. It can be suggested that this syndrome may be more pronounced in patients with essential hypertension. Stable changes in the electrodermal activity of the palms of in-

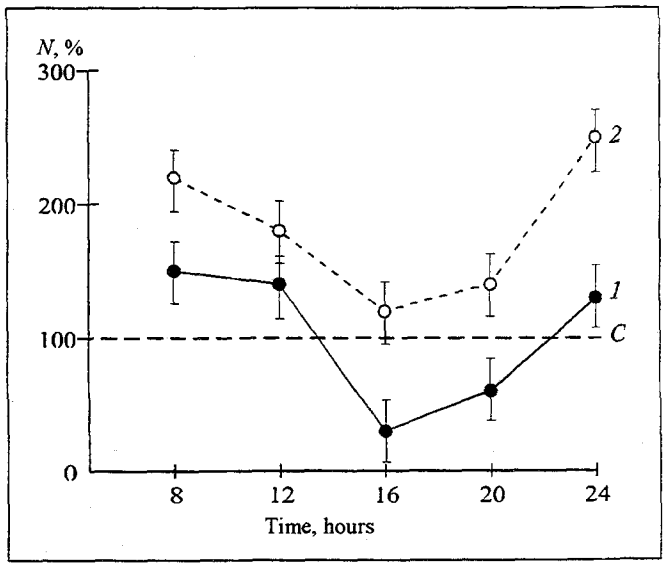

Fig. 2. Time course of the Kerdaux vegetative index in normal subjects (*1*) and patients with essential hypertension (2) over a 24-hour period. Ordinate: percent of deviation of the parameter from the mean over 24 h for normal subjects (*C*).

dividuals suffering from chronic neurotic diseases [4] permit such a hypothesis.

Changes in epidermal EP asymmetry occurring in patients with essential hypertension may be also due to inversion of autonomic reactions and reflect increased vulnerability of the left hemisphere [5]. Moreover, there are good grounds to assert that there is an optimal range of EP K_{as} values for health and disease. However, our findings prompt us to take the biorhythmological factor into consideration, too. The optimal period for recording the epidermal EP is from 13:00 to 20:00, when the differences in the EP K_{as} in normal subjects and patients are maximal, whereas the period from 11:00 to 13:00 and from 21:00 to 23:00, when these differences are insignificant, is unfavorable.

Stable predominance of the left hand epidermis EP in normal subjects and of the right temporofrontal area of the head confirm our hypothesis on the role of the interhemispheral relations in the formation of the asymmetry of electrodermal activity [7]. Presumably, the left-side asymmetry of EP is an indicator of the optimum interhemispheral relations, and a decrease or inversion of K_{as} in patients indicates disorders of this optimum. The existence and role of ipsilateral effects of the cerebral hemispheres on the hand epidermis EP cannot be ruled out, but we believe that the contralateral projections are more potent.

Our findings are helpful for a better understanding of the mechanisms mediating the relationships between changes in EP asymmetry and the interhemispheric relations.

Thus, circadian rhythms of the hand epidermis EP in normal subjects and patients with essential hypertension depend on the level of sympathoadrenal activity, whereas the asymmetry of EP is related to the regulatory role of cerebral hemispheres.

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