Diurnal rhythms of skin electrical conductivity at acupuncture points

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The chronobiological aspect of cognition of the regularities of the functioning of living things at the present stage is one of the most urgent problems of biology and medicine. The values of temporal rhythms vary within a very wide range. At the same time, there are many rhythms in certain hierarchical relationships, this is the daily rhythm of the change of day and night, seasonal - the alternation of the seasons. In biological systems, for example, heart rate. In the existing hierarchy of rhythms, there can be only a few rhythms that are dominant in amplitude at the same time. The superposition of rhythms determines the complex shape of the time series [1, 2].

It is known from the literature that the system of acupuncture points consists of 12 paired (main) and 2 unpaired meridians or channels that combine 365 points of active action [7]. The vital energy "qi" circulates through the system of meridians (channels), completing its turn during the day. The energy of "qi" is subdivided into "yang" and "yin" quality. The maximum filling of the meridian with yang or yin energy lasts only two hours a day. Each state of "yang and yin" lags behind each other by 12 hours.

In previously published works, researchers subdivide changes in the electric potential of the skin over time into three components [4]:

- slow component, level of electrical conductivity (background skin reaction);
- a fast component as a reaction to a known irritation (phasic reaction);
- a fast spontaneous component as a reaction to an undefined stimulus (spontaneous phasic reaction).

It is assumed that the identification of common, characteristic for biologically active points of background fluctuations of electrical conductivity, will allow to study the influence of normal physiological processes on the dynamics of electrical conductivity of biologically active points (EP BAP).

The aim of this study was to analyze slow or background fluctuations in the electrical conductivity of biologically active points of the skin in the natural mode of daily activity of a practically healthy person.

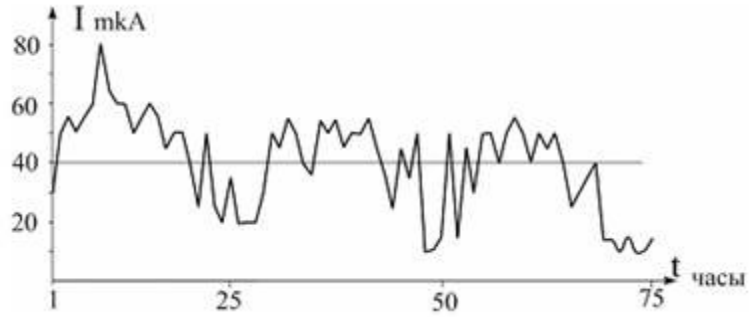
Materials and research methods

The study of EP BAP was carried out in practically healthy subjects at 24 points - representatives of 12 paired meridians recommended for measurement by the Ryodoraku method [5,6]. In several subjects, the study of EP BAP was carried out for two days at all points of the meridians of the heart and pericardium. The measurements were carried out with an interval of 1 hour, using the "Homeotron" MAT-600 apparatus (Japan). The base voltage is 12 V, the calibration was carried out at a short-circuit current of 200 mA, the search electrode is wet. The study duration varied from 1.5 to 3 days. The measurement points were located according to

anatomical and topographic description according to Atlas [7].

Results of the study of the daily dynamics of EP BAP12 studies were carried out, each lasting from one and a half to three days. Care was taken to ensure that the daily activity regimen was identical in all studies. Measurements were made every hour. In 10 studies, each measurement implementation corresponded to the scheme proposed by Nakatani [5], in 2 others, the points of paired meridians of the heart and pericardium were measured [7]. As you know, these meridians contain 9 points each.

To illustrate the analysis of harmonic oscillations, let us consider its algorithm using the example of a 75-hour experiment carried out by the subject "S" on the implementation of measurements at point RP3 (tai-bai) (see Fig. 1).



Rice. 1. Graph of changes in electrical conductivity for 3 days (75 hours) for the subject "S" at point RP3 (tai-bai).

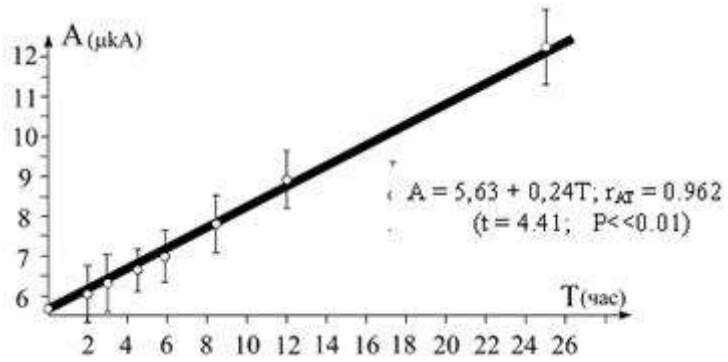
The data of this implementation were processed by FFT programs, smoothing and highlighting significant harmonics.

The first three calculated sinusoids have: 1 - an amplitude of 15.35 mkA with a period of 25.01 hours; 2 - amplitude of 10.22 mkA with a period of 251.94 hours and 3 - amplitude of 2.91 mkA with a period of 2.02 hours.

The next four selected sinusoids have: 1 - an amplitude of -5.42 mkA with a period of 5.34 hours; 2 - amplitude 3.66 mkA with a period of 4.67 hours; 3 - an amplitude of 3.74 mkA with a period of 7.82 hours and 4 - an amplitude of -4.54 mkA with a period of 2, 16

hours. The amplitudes of the arising intraday harmonics gradually decrease and decay, new ones are superimposed on them, etc. Thus, a complex dynamics of the diurnal rhythm is formed.

Using the method of spectral analysis, the harmonics of the components of the diurnal dynamics at all measured points were identified. Joint statistical processing for all the above studies made it possible to establish the following regularities (see Fig. 2).



Rice. 2. Dependence of the amplitude on the length of the harmonic period in the dynamics of the diurnalskin cycle at acupuncture points, where: A - harmonic amplitude; t is the harmonic period.

Statistical calculations for all amplitudes of intraday harmonics, their periods and phases show an internal relationship with each other. Correlation coefficients between amplitudes, frequencies and phases of harmonics with a high degree of confidence are close to unity: (R_{AT} = 0.879; P <0.01) [8]. The 95% confidence interval of the correlation coefficient according to the Z-criterion lies in the range: 0.795 ≤ 0.962 ≤ 0.999. The type of relationship (Fig. 2) is determined by the linear regression equation: A = 0.24 × T + 5.63.

A decrease in the magnitude of the amplitude with an increase in the frequency of the oscillatory process of the EP in the BAP may indicate the self-generation nature of the generation within the daily harmonics. But in this case, the relationship between the frequency and phase shifts of the components of the diurnal dynamics harmonics should be revealed. In order to verify this assumption, a spectral analysis of time series was carried out, consisting of the EP BAP values measured during a 50-hour experiment with the calculation of phase shifts of the harmonic components of daily dynamics relative to the beginning of the experiment.

The calculation of the relationship between the length of the period and the magnitude of the phase shift relative to the beginning of the study confirms the assumption made above:

$r_{T;\,+j}$ = -0.621 (t = 1.625; P <0.20) $r_{T;\,-j}$ = +0.833 (t = 2.678; P <0.05) [3].

About the same level, strong correlations were revealed in the analysis of the oscillatory processes of the EP BAP along the meridians of the heart and pericardium: $r_{A;\,T}$ = 0.644 ± 0.176, as well as according to the results of five studies (lasting several days) in the same subject at points P7 (le-chue) and C7 (shen-men) ($r_{A;\,T}$ = 0.87 ± 0.04).

The indicated periods of harmonics, with an equally probable manifestation in a daily cycle, would have equal frequencies of manifestation and would have a value equal to 0.125. In reality, their manifestation is different: some are very rare, for example, 0.032, others are significantly (almost twice) more often - 0.236.

Comparison of the results indicates a certain stability of the background harmonic oscillations of the EP BAP during the day for almost

healthy subjects. Individual variations in intraday fluctuations in the background component of electrical conductivity are due to the peculiarities of the regime, the state of each subject, and his genetic status. Distortions in the general picture of diurnal dynamics can also be caused by the fact that measurement of EP BAP at nighttime sometimes causes the subjects to awaken from sleep.

Power spectra of time series of EP BAPs of different meridians and different BAPs of the same meridian differ significantly only in the frequency range 0.3–0.5 hours^{-1}... This can be caused by the following factors: when measuring the EP by the method of short-term (2–3 s) contact with the working electrode of the investigated area of the skin, a reaction to the action sometimes appears (application of the electrode, operator effect, extraneous noise). The EP value in this case for a short period of time increases by 1.5–3 times (sometimes by 5–7 times). The magnitude of the jump depends on many reasons, including the average background conductance and neuro-emotional stress of the subject. Thus, the differences in the "high-frequency" region of the spectrum are apparently due to the presence of fast components (GSR - galvanic skin reactions) in separate measurements of EP.

The daily harmonic, as the most powerful component of the rhythm, is the basic one. It depends on the degree of activation of the cerebral cortex during the day and is in tune with the circadian processes of the external environment. Ultraradian (intraday) rhythms can be generated at any time of the day. For their occurrence, an external stimulus is required that causes an electrodermal reaction. This stimulus is the beginning of a new harmonic, the amplitude and frequency of which depend on the phase of the individual basic daily cycle.

Conclusion

1. The electrical conductivity of the skin at acupuncture points has a complex intraday rhythm is a superposition of rhythms (sets of harmonics).

2. Circadian (diurnal) rhythm of electrical conductivity fluctuations skin at acupuncture points is the basic rhythm and is the most powerful in amplitude.

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