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COMPLEX SYSTEMS BIOPHYSICS

Electrical Properties of Human Skin: New Data

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Abstract—The results of research of the electrical properties of the human skin when exposed to prescribed electrical power are shown. The issues of improving the data validity are discussed.

Keywords: acupuncture loci, prescribed electrical power

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The skin cover of the human presents as a border medium between inner organs and outer world. It has a mosaic structure (parameters of the skin cover, both electrical and physiological, are distinct in different zones, for example tender Head's zones, acupuncture points, etc.), the parameters of which change under influencing impacts. In this way, provided is a thermodynamic equilibrium of the organism with external medium (at admissible levels of impacts).

The actuating parameters may have different nature, namely: electrical, mechanical, thermal, light, magnetic, hydraulic, radiation, etc. The parameters of skin cover are such that for a normal condition of the organism, at any impact, provided is a thermodynamic equilibrium between external medium and inner organs.

Determining a normal condition of a local skin cover zone it easily managed only by electric parameters. By the voltage drop at a constant value of the actuating electric power (upon actuating with preset values of current/voltage pulses on a skin cover having a different value of electric resistance, upon uncontrolled impact energy they obtain unreliable information in the response) one manages to evaluate the condition of skin cover and an acupuncture point (AP) in particular. Upon mechanical impact on an AP disposed on the skin cover, its parameters, in that number electric ones, change.

Measurement of electric resistance of skin cover is widely used in bioimpedancemetry, in particular for evaluation of the composition of the body, condition of water exchange, prognosticating tissue viability in transplantation and life expectancy in fatal diseases, etc.

We have proposed to measure the electric resistance of nonlinear heat-dependent objects (having in current–voltage characteristics some regions with negative differential resistance) by acting on the object with a pulse with a prescribed value of electric power, which allows providing metrological certainty and reproducibility of the measuring regime upon a change of object resistance [1–3]. At a small voltage drop on a region with AP, in accordance with the terminology of traditional Chinese medicine [4, 5], this is the so-called state of "fullness" and the "Qi" (in some translations "Chi") energy must be "dissipated." At a large voltage drop—this is "emptiness" and the "Qi" energy must be "tonified." For dissipation into the AP a needle is introduced, left for a comparatively long time, and then taken out.

For determination of the state of AP use is made of the methods of Voll and Nakatani [6–8], in which with the aid of a source of electric voltage or current they evaluate the resistibility to electric current of biological tissue. Modifications of methods were elaborated by A.I. Nechushkin, H. Motoyama and in due time investigated in the Central Scientific Research Institute of Reflexotherapy of the Ministry of Health of the USSR (Moscow) by S.M. Zol'nikov, O.N. Kozlov, V.A. Zagryadskii, A.S. Zimin, in the All-Union SRI of General and Forensic Psychiatry named after V.P. Serbsky (at the present time State Scientific Center of Social and Forensic Psychiatry named after V.P. Serbsky, Moscow) by I.Sh. Akhtyamov et al.

The needle stays in tissue up to the moment when the resistance of biotissue around the needle to electric current assumes a value characteristic of a concrete organism. By this value one may evaluate the physiological condition of each of energetic "meridians" ("channels") of the organism, which is extraordinarily

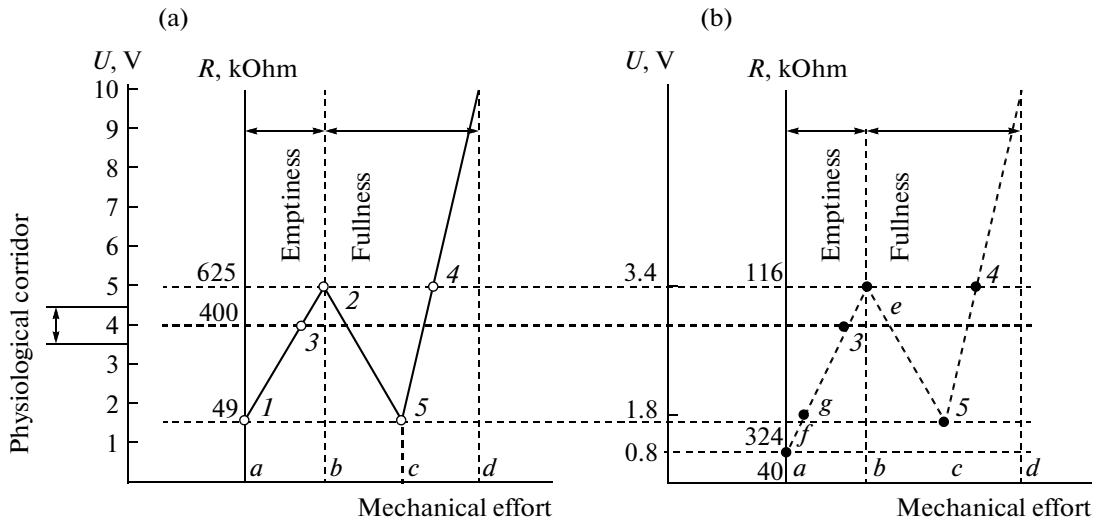

Fig. 1. Characteristic of AP upon mechanical impact on it.

important for diagnosing its condition. It is not excluded that the obtained results characterize also the psychophysiological condition, which is important for treating data obtained on "lie detectors."

But in these methods and technical means realizing them there is an essential drawback—the result of evaluating the resistibility of the organism to electric current does change upon a change of the therein dissipated electric power. This for a long time has not been taken into account by specialists developing medical techniques of diagnostic purposes (in that number, one of the authors of the present article [1, 6, 9]). Eventually the results had poor repeatability and low reliability, individual calibration of the equipment was required, treatment of the obtained data demanded intuition and great experience. The energetic approach to evaluation of the state of biological matter considered in works [2–4, 10, 11] has allowed stabilizing the indications and providing their repeatability and reproducibility. The essence of it consists in that evaluation of the state of both living and nonliving matter is conducted at constant electric power. This approach permits conducting evaluation of the state and attainment of reproducible results in evaluation of the state of any nonlinear objects.

A device on the basis of the energetic concept realized by an author of the given work A.Yu. Demin has allowed proposing an equivalent characteristic having the form shown in Fig. 1.

At a normal state of AP, provided absence of mechanical impact, the position on the characteristic is determined by point *3*. The electric resistibility in the authors of the article at this point upon constant power of dissipation $P = 40$ μW equals $R = 400$ kOhm and the voltage drop equals 4 V. Probably, this parameter has a value individual for every human, and characterizes the physiological condition of a concrete human.

If the resistance of AP residing on the skin cover has a value characterized by point *3*, i.e. 400 kOhm at $P =$ 40 μW, the "Qi" energy circulates normally over all organs and meridians. If resistibility to mechanical impact resides below point *3* upon moistening of the zone of AP, then it is "fullness," which should be "dissipated."

If the resistance resides above point *3* on the curve of the characteristic of AP, then it is "emptiness," which should be "tonified." Between points *1* and *2* there resides a physiological corridor, which is estimated at 10–15% of resistibility at point *3*, which is commensurate with values that were obtained by authors using the method of Nakatani. Thus if one taken a value of 10%, then in the limits of the physiological corridor the normal resistibility is estimated by voltages of 3.6 and 4.4 V, respectively $R = 324$ kOhm and $R = 484$ kOhm. If at point *3* the resistibility is characterized by other voltage drops, then otherwise will be the quantitative indices too.

The "fullness" conditioned by reaction to mechanical impact is "dissipated" either by quick introduction of a needle into AP or by placement of a vacuum cup onto AP. The walls of a vacuum cup, deforming the skin cover around the needle, strengthen its action. Upon "dissipation" the AP on the characteristic ascends upwards and, passing near point *3*, is "captured" and held by the organism. The accuracy of "capture" and possibility of "holding" depend on the condition of the organism. If AP "skips" point *3*, then the biotissue falls into the zone of "emptiness" (resistibility greater than 400 kOhm, according to authors' data). The voltage drop therewith constitutes more than 4 V. If the voltage drop reaches a level character-