NEAR-FIELD MICROWAVE SENSING OF HUMAN SKIN: PHYSIOLOGICAL PATTERN

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The skin remained the subject of histological examination for a long time, as it is difficult to visualize [2, 5]. Existing methods (for example, optical coherence tomography, IR thermography, etc.) allow to study only the surface and the nearest subsurface structures of the skin, and the deep structure of the latter is difficult for non-invasive study [5]. In this regard, the work on profiling the skin by its dielectric properties attracts attention [1–4], however, this information is isolated and fragmentary. This is, in particular, due to the lack of available diagnostic tools for assessing the dielectric characteristics of the skin and other tissues [2, 4]. In this regard, the aim of the study was to study the possibilities of near-field microwave sensing in assessing the structure of human skin.

Material and methods. The study, which included a single microwave sounding, was performed in 35 healthy volunteers. Near-field microwave sensing of tissues was performed using a special installation created at the Institute of applied physics of the Russian Academy of Sciences (Nizhny Novgorod), as well as specialized software that matches the installation with a PC and allows to calculate the real part of the dielectric permeability [1, 2]. The dielectric characteristics of the skin were evaluated at depths of 2 to 5 mm using a series of probes. Measurements were performed on the forearm at a single point. The data were processed in the software package Statistica 6.1.

Results. It was found that the real part of the dielectric permeability of human skin monotonically elevates with increasing depth of sensing (Fig. 1), showing a tendency to increase by 1.74 times when comparing the parameter values obtained at depths of 2 and 5 mm ($p<0.05$). This is due to the fact that the value is cumulative, and each subsequent value includes the previous as well as the contribution made by tissues from the previous to the current level of sensing. On the basis of the data obtained, a linear mathematical model of

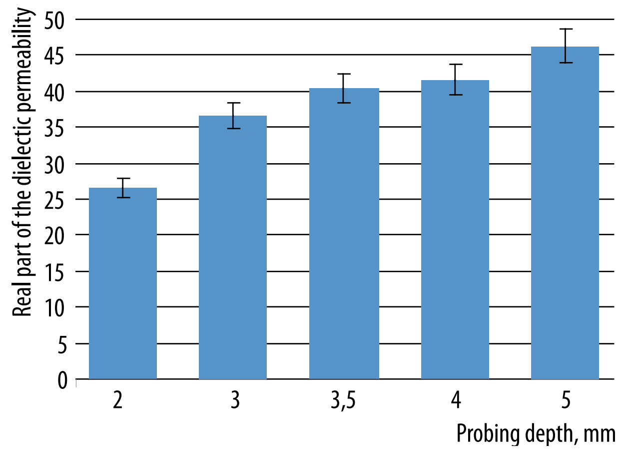

***Fig. 1.** Profile of dielectric permeability in healthy people (in rel. un.)*

the change in the dielectric permeability of the skin is constructed, which sufficiently describes its subsurface profile (determination coefficient — 0.94). The linear regression equation, which allows to predict the value of dielectric permittivity at other sensing depths, is presented in the following form:

$$y = 6.4125 \cdot x + 15.844,$$

where y — real part of dielectric permeability, x — depth of sensing.

Conclusion. Our research allowed to establish a picture of the deep distribution of the dielectric permeability of the skin of healthy people, which can serve as a physiological microwave pattern for the study of subsurface tissues, including various layers of the skin and the nearest subcutaneous structures. It is shown that the real part of the dielectric permittivity elevates monotonically with an increase in the sensing depth in the range from 2 to 5 mm in increments of 0.5 to 1 mm.

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