

Diagnostics of peripheral blood flow disorders in various pathologic conditions using wearable laser Doppler flowmetry devices

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ABSTRACT

Involvement of the blood microcirculation system in many functions of the body leads to the fact that the microcirculatory bed is one of the first links in the pathogenesis of various diseases, such as diabetes mellitus (DM). The aim of the present work was to improve the quality of diagnostics of peripheral blood flow disorders by developing a diagnostic method based on a distributed system of wearable laser Doppler flowmetry (LDF) devices without the use of functional tests.

In the present work, we conducted a study involving patients with diagnosed type 2 DM [1], conditionally healthy volunteers of different age groups [2] and patients undergoing rehabilitation after COVID-19 coronavirus infection [3]. The study consisted of a 10-minute recording of LDF signals simultaneously in the upper and lower limbs without the use of functional tests. Distributed system of wearable analyzers “LAZMA PF” (SPE “LAZMA” Ltd.) was used for registration of LDF signals. The devices were placed on the dorsal surface of wrists, the volar surface of the of fingers and toes and the inner surface of the upper third of the shins. During the measurement. patients were placed in the supine position.

The results of the study revealed an increase in the index of microcirculation (I_m , p.u.) and a decrease in the regulatory activity of blood flow with aging. In patients with DM the decrease in the level of I_m and nutritive blood flow (I_{mn} , p.u.) in the toe area and an increase in these parameters in the wrist area compared to the control group. Also, patients were characterized by decreased myogenic tone in the wrists and decreased contribution of the endothelial oscillations in the total power of the LDF wavelet spectrum in the upper and lower extremities. The contribution of pulse oscillations was elevated in patients in the feet, which may indicate an increase in the vascular wall stiffness. The findings in the wrists may indicate that the body is attempting to compensate for the disturbances in the microcirculation by activating nutritive blood flow and increasing the number of functioning capillaries. Patients with long COVID-19 syndrome were characterized by decreased values of I_m and I_{mn} , as well as increased total oscillatory activity of blood flow in both upper and lower extremities.

Thus, the developed approach to diagnostics of peripheral blood flow disorders, based on the use of wearable LDF analyzers, has been tested in clinical conditions and demonstrated the ability to detect peripheral blood flow disorders in various pathological conditions.

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REFERENCES

- [1] E.V. Zharkikh et al, Human Physiology, 48(4), pp. 456-464, 2022.
- [2] E.A. Zharebtsov et al, in Biomedical Photonics for Diabetes Research, pp. 107-135.
- [3] E.V. Zharkikh et al, Diagnostics 13(5), 920, 2023.