Wearable laser Doppler flowmetry implementation for the analysis of microcirculation disorders

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Microcirculation plays an important role in maintaining the normal functional state of the body and is one of the first links involved in the development of various pathological processes [1, 2]. The laser Doppler flowmetry (LDF) is one of the most common methods to assess the blood microcirculation system state. Currently, there is a surge of interest in wearable electronic diagnostic devices, including ones that implement the LDF. The aim of this work was to assess the possibilities of using the novel wearable blood perfusion sensor system to evaluate impaired microcirculation in diabetes.

The studies were approved by the Ethics Committee of the Orel State University. The study involved 37 healthy volunteers, divided into 2 groups accordingly to their age, and 18 patients with type 2 diabetes (9men, 53.2±11.4 years). The 1st group of volunteers consisted of 16 subjects (8 men) with the age of 19.6±0.6 years, the 2nd group included 21 volunteers (10 men) with age of 52.6±10.2 years. All other parameters of these two groups except age did not have statistically significant differences. A novel wearable distributed multipoint LDF system consisting of four "AMT-LAZMA 1" devices (Aston Medical Technologies Ltd., UK) was used to analyse microcirculatory blood flow. The system consists of peripheral blood flow analyzers and can be used to record the microcirculation index simultaneously from several points of the body. Volunteers sat with their hands at heart level. The analyzers were located on the dorsum of the wrists and on the volar surface of the middle fingers. Each study consisted of a 10-minute recording of the LDF signal simultaneously from 4 points and subsequent data processing.

The highest level of microcirculation was registered in the second control group, and the lowest - in the younger group of healthy volunteers. The microcirculation index in patients was significantly higher than in the young control group but less than in the second one. The result may be associated with age-related changes in the blood microcirculation. In previous works, an increase in perfusion with age was explained by morphological changes in the microcirculation system [3]. Microcirculation disorders have also been demonstrated in patients with diabetes, due to various reasons [4].

The study has shown that the use of a wireless wearable fibre-free LDF device is a very convenient solution for use in a point-of-care diagnostics. A promising direction in the development of the sensors is the analysis of the microhemodynamics parameters synchronization while simultaneously measuring the signal from symmetrical parts of the body.

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