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POSSIBILITIES OF DOPPLER SPECTRUM ANALYSIS OF LASER RADIATION RECEIVED FROM HAND SKIN DURING FUNCTIONAL TESTS

Igor Kozlov[*1], Victor Dremin[1], Angelina Zherebtsova[1], Evgeny Zherebtsov[2]

[1] *Scientific-Educational Center "Biomedical Engineering", Orel State University, Orel, Russia*
[2] *Aston Institute of Photonic Technologies, Aston University, Birmingham, United Kingdom*

**Contact: igor57_orel@mail.ru*

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Laser Doppler flowmetry (LDF) is well-known non-invasive diagnostic technique using for evaluation the functional conditions of microvascular system [1, 2]. Laser Doppler flowmetry (LDF) is widely used to measure the "index of blood microcirculation" (or perfusion) in patients. According to Bonner and Nossal [3], index of microcirculation, in general, is proportional of RBC concentration and velocity in diagnostic volume [4]. In concordance with classic algorithm of signal processing with wide range of frequency integration, significant information about blood perfusion distribution is lost. In this research, we offer direct utilization of Doppler spectra and registration perfusion distribution by frequency range [5].

The LDF-device with appropriate optic, custom electronic board and digital signal processing was developed. The digital processing algorithm provides computing and saving index of microcirculation in sub-bands of power spectrum for blood perfusion alterations during functional tests (occlusion, breath-holding and local pressure) to be obtained.

Occlusion test was chosen as a provocative factor in order to reliably provoke perfusion alternations. Fourteen healthy volunteers with a mean age 21 years old were involved in experiment simultaneously recording LDF-grams integrated by following sub-bands: 60 – 400 Hz; 400 – 800 Hz; 800 – 1600 Hz; 1600 – 3200 Hz; 3200 – 6400 Hz. Also, breath-holding tests were recorded according to protocol with sharp inhale-exhale breath containing 1 min background perfusion recording, sharp inhale-exhale breath and over 1 min post-exhaling recording period. The same spectral sub-bands were chosen for signal processing test of breath-holding test as occlusion test. Experiment included 6 healthy volunteers. For the influence of local pressure on perfusion distribution to be investigated, an appropriate device was created containing special 3D-printed tooling and a set of weights. The measurement was conducted on the dorsal surface of right middle finger. The special tooling was placed coaxially to optic fiber. Weights were consequently placed into tooling until a pressure was 40 kPa. At the next stage, weights were removed upside-down. Experiments were conducted on 7 healthy volunteers and lasted about 50 minutes.

Performed experiments showed that perfusion distribution by frequency of Doppler shift has transient nature during different provocative factors. Breath-holding tests, occlusion tests and local pressure tests demonstrated opposite reaction of index of microcirculation in various sub-bands. The proposed method of signal processing can potentially ensure information receiving from various structure units of microvascular system (arterioles, capillaries, venules and lymph vessels).

This research is a step for development of wearable LDF technology. The created processing algorithm will be realized in perspective LDF-device with new diagnostic criteria based on perfusion distribution analysis and more flexible using of primary data.

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