WEARABLE LASER DOPPLER FLOWMETRY IMPLEMENTATION FOR THE ANALYSIS OF MICROCIRCULATION DISORDERS

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MICROCIRCULATORY DISORDERS IN SOCIALLY SIGNIFICANT DISEASES

The microcirculatory bed is a complexly organized system that exchanges between blood and tissues, necessary for ensuring cellular metabolism and removal of metabolic products. The microcirculation system is the first link that is involved in the pathological process in various extreme situations. The list of diseases associated with impaired microcirculation includes, but is not limited to: diabetes, peripheral vascular disease, hypertension, aortic aneurysm, hypercholesterolemia, renal failure.

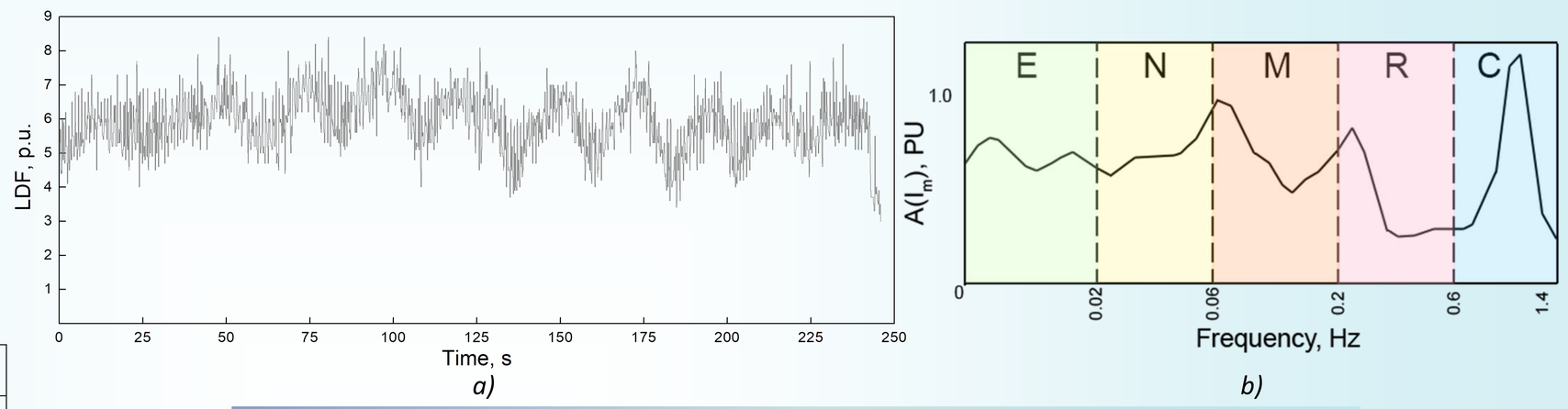
The laser Doppler flowmetry (LDF) is one of the most common methods to assess the blood microcirculation system state. **The aim of this work was to assess the possibilities of using the novel wearable blood perfusion sensor system to evaluate impaired microcirculation in diabetes.**

MATERIALS AND METHODS

A novel wearable distributed multipoint LDF system [1] consisting of four "AMT-LAZMA 1" devices (Aston Medical Technologies Ltd., UK) was used to analyse microcirculatory blood flow. Volunteers rested supine with their hands at heart level, the analyzers were located on the dorsum of the wrists and on the lower leg from the outside.

Appearance of the devices

Groups under the study		
Healthy volunteers		Patients (53.2±11.4 years)
Younger group (19.6±0.6 years)	Older group (52.6±10.2 years)	
16 (8 men)	21 (10 men)	18 (9 men)



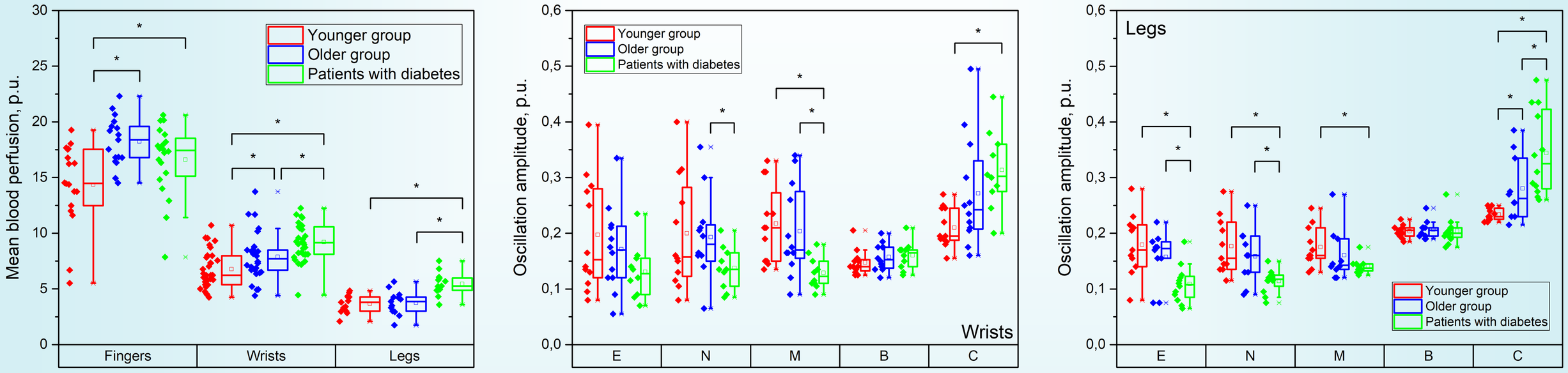
The typical view of the LDF signal for a 4-minute recording (a) and the wavelet analysis of the record (b)

Spectral ranges of the oscillations in fine structure of capillary blood flow:

• Pulse band (0.6–2 Hz) – heart activity; • Respiratory (0.145–0.6 Hz) – movement of the thorax; • Myogenic (0.052–0.145 Hz) – vascular smooth muscle cells reaction; • Neurogenic (0.021–0.052 Hz) – sympathetic vasomotor activity; • Endothelium vascular tone regulation (0.0095–0.021 Hz).

RESULTS AND DISCUSSION

Statistically significant differences were found for the group of patients compared with the control, as well as for age-different groups of healthy volunteers [2]. In general, there was an increased level of microcirculation index in older volunteers and higher values in patients compared with the control. 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 graphs show the obtained data for measurements on the wrists and legs, as well as their comparison with previously obtained data for the pads of the middle fingers.



The average values of the microcirculation index (a) and the amplitudes of the blood flow oscillations in the study areas: (b) for the wrists and (c) for the lower leg

CONCLUSIONS

- 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.

ACKNOWLEDGEMENTS

The work was funded by the Russian Science Foundation (the research project 18-79-00237).

Evgeny Zherebtsov kindly acknowledges for personal support from grant of Academy of Finland No.318281.

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