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Influence of the Local External Pressure on Measured Parameters of Cutaneous Microcirculation

Authors : Irina Mizeva, Elena Potapova, Viktor Dremin, Mikhail Mezentsev, Valeri Shupletsov

Abstract : The local tissue perfusion is regulated by the microvascular tone which is under the control of a number of physiological mechanisms. Laser Doppler flowmetry (LDF) together with wavelet analyses is the most commonly used technique to study the regulatory mechanisms of cutaneous microcirculation. External factors such as temperature, local pressure of the probe on the skin, etc. influence on the blood flow characteristics and are used as physiological tests to evaluate microvascular regulatory mechanisms. Local probe pressure influences on the microcirculation parameters measured by optical methods: diffuse reflectance spectroscopy, fluorescence spectroscopy, and LDF. Therefore, further study of probe pressure effects can be useful to improve the reliability of optical measurement. During pressure tests variation of the mean perfusion measured by means of LDF usually is estimated. An additional information concerning the physiological mechanisms of the vascular tone regulation system in response to local pressure can be obtained using spectral analyses of LDF samples. The aim of the present work was to develop protocol and algorithm of data processing appropriate for study physiological response to the local pressure test. Involving 6 subjects (20±2 years) and providing 5 measurements for every subject we estimated intersubject and-inter group variability of response of both averaged and oscillating parts of the LDF sample on external surface pressure. The final purpose of the work was to find special features which further can be used in wider clinic studies. The cutaneous perfusion measurements were carried out by LAKK-02 (SPE LAZMA Ltd., Russia), the skin loading was provided by the originally designed device which allows one to distribute the pressure around the LDF probe. The probe was installed on the dorsal part of the distal finger of the index figure. We collected measurements continuously for one hour and varied loading from 0 to 180mmHg stepwise with a step duration of 10 minutes. Further, we post-processed the samples using the wavelet transform and traced the energy of oscillations in five frequency bands over time. Weak loading leads to pressure-induced vasodilation, so one should take into account that the perfusion measured under pressure conditions will be overestimated. On the other hand, we revealed a decrease in endothelial associated fluctuations. Further loading (88 mmHg) induces amplification of pulsations in all frequency bands. We assume that such loading leads to a higher number of closed capillaries, higher input of arterioles in the LDF signal and as a consequence more vivid oscillations which mainly are formed in arterioles. External pressure higher than 144 mmHg leads to the decrease of oscillating components, after removing the loading very rapid restore of the tissue perfusion takes place. In this work, we have demonstrated that local skin loading influence on the microcirculation parameters measured by optic technique; this should be taken into account while developing portable electronic devices. The proposed protocol of local loading allows one to evaluate PIV as far as to trace dynamic of blood flow oscillations. This study was supported by the Russian Science Foundation under project N 18-15-00201.
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