Simultaneous assessment of blood flow rhythmic oscillation by using of laser Doppler flowmetry and videocapillaroscopy methods

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Videocapillarosopy is well-known method for evaluate of microvascular abnormalities such as Raynaud phenomenon and system sclerosis. This method is based on registration of frames series representing capillary blood flow and capillary forms. Other method that widely used for blood flow analysis is Laser Doppler Flowmetry (LDF). The main phenomenon in this technique is registration of laser radiation back-scattered from moving red blood cells. Recorded and digitized photocurrent is processed and after necessary computing operations we received index of microcirculation (Im.) This parameter is proportional to red blood cells velocity and concentration in diagnostic volume (1-3 mm3).

As index of microcirculation depends from blood dynamic in microvasculature, the graph of Im contains biological rhythms (endothelial, neurogenic, myogenic, breath, heart). A special interest for diagnostics can be the wavelet analysis of these oscillations during functional tests (occlusion, temperature, etc). The significant changes in the registered spectra usually can be associated with microcirculation insufficiency occurring with various rheumatic and endocrine syndromes.

Today, there are many doubts that LDF method can provide diagnostic information about blood flow oscillations and rhythms. In this research, we performed an objective comparison between the integral evaluation of blood flow by LDF and the single-capillary estimation by VCS.

The possibility to calculate the blood flow velocity in a single capillary was realised by the video capillaroscopic method. The in-house custom build setup consists of optical subsystem, high-speed IDS UI3060-CP camera and side illumination subsystem. In the system, the registered sequences of frames with a frame rate of 200 fps are processing by the novel dedicated algorithm.

A custom developed laser Doppler measuring channel supplemented by the dedicated software was used for the registration of perfusion. The signal processing model was implemented in the NI LabVIEW environment to calculate the index of microcirculation. The NI USB 6211 data acquisition board was used to digitise the received signal. Morlet wavelet transformation is used to calculate the spectra of registered signals.

A series of parallel 10-minute experimental records of the microcirculation index and videocapillaroscopic measurements were conducted.

The proposed approach demonstrated the essential correlation between spectra oscillations in the isolated capillary and the integral estimation of the microcirculation index by the laser Doppler flowmetry method. This result demonstrates the deep connection of the LDF signal with objective physical characteristics of the skin blood microflow.