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Development of Algorithm for Real Time Assessment of Microcirculatory Dynamics by Image and Finite Element Analysis of Skin Microcirculation

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Abstract. We developed a system for real time measurement of the microcirculatory blood vessel dynamic or vasomotion using intravital microscopy (IVM) data and finite element analysis (FEM). The time-dependent velocity at the center of the blood vessel was measured by phase-contrast algorithm based on Origin pro-software (Origin Lab Inc.) and was approximated by finite Fourier series, which was used for generating the velocity profile at the inlet for the boundary condition to the FEM method. To validate the FEM method, we compared real time vasomotion image data with obtained by the FEM method theoretical values in a straight cylinder with various radii for both steady and pulsatile flows.

After recording of vasomotion- rhythmic oscillations in blood vessel diameter measured by IVM we analyzed the nonlinear signal of those oscillations by means wavelet analysis. Vasomotion is caused by local changes in blood vessel smooth muscle constriction and dilation.

Wavelet analysis is an accurate and reliable tool for studying signals with changes of phase and frequency. Arterioles between 45 and 80 μm in diameter were measured. Spectral range of oscillations with physiological relevance are found, from 0.0095 to 1.2 Hz, and four subintervals are revealed, (0.0095–0.02 Hz), (0.02–0.05 Hz), (0.05–0.14 Hz) and (0.14–1.2 Hz), by wavelet analysis. In this work our group applied wavelet Daubechies analysis. Daubechies wavelets are a family of orthogonal wavelets defining a discrete wavelet transform.