On the Elastic Properties of Red Blood Cells Investigated by Time Dependent Laser Speckle Pattern

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In the last years it was demonstrated that elastic features like the Young's modulus of cells are strongly related to their functionality, whether the cells are healthy or changed by diseases. Especially, the loss of complex features in cancerous cells is accompanied by significant reduction of their Young's modulus in comparison with healthy cells. So far, the elastic moduli of various cells were determined by ex vivo methods, only. In contrast to that time dependent Laser Speckle pattern allow e.g., to look for the flow and deformation of the red blood cells in near to the surface lying vascular systems. The best location for that would be the eye retina, however, for first tests the micro-capillary blood system at the nail fold can be well investigated by the Speckle technique with red laser. Recording 380 frames per second the blood pulsation could be significantly viewed by the Speckle contrast for a small area of interest of 30x30 pixels. The detailed analysis of the time dependent Speckle pattern is carried out by the help of time and spatial correlation function. In both cases the experimental data were fitted to the stretched exponential functions, which yield important parameters to characterize the vascular system and red blood cells, e.g., their size as a function of time and the fractal dimension of the distribution of red blood cells. An additional oscillating part in the model for the time dependent correlation function allows to estimate the blood pulsation rate. The most interesting result was obtained for the variation of the size for the red blood cells in the range of 6-8 µm during pulsation. Using the auto-correlation images of a 100x100 and 500x500 pixel-AOI for the contrast pattern and their dependence on the radial distance of the considered correlated intensities the RBC size, the Fractal dimension of the RBC surface and RMS value of the contrast images averaged over the AOI were estimated. The obtained data allow to determine even the Young's modulus for the BRC based on a reasonable mechanical model. All these parameters were determined for 15 healthy volunteers. Interesting correlation of these parameters with the age and the lifestyle were found. Improving technical details of the Speckle measurements forthcoming studies with persons having different healthy problems could be opened the way to apply the proposed testing method for diagnostic purposes.