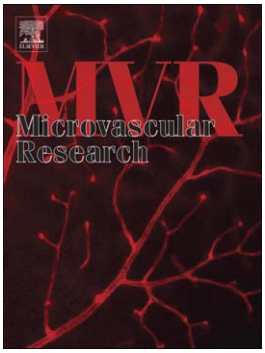

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Oxygen saturation, red blood cell tissue fraction and speed resolved perfusion - A new optical method for microcirculatory assessment

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Abstract

We have developed a new fiber-optic system that combines diffuse reflectance spectroscopy (DRS) and laser Doppler Flowmetry (LDF) for a multi-modal assessment of the microcirculation. Quantitative data is achieved with an inverse Monte Carlo algorithm based on an individually adaptive skin model. The output parameters are calculated from the model and given in absolute units: hemoglobin oxygen saturation (%), red blood cell (RBC) tissue fraction (%), and the speed resolved RBC perfusion separated into three speed regions; 0-1 mm/s, 1-10 mm/s and above 10 mm/s (% mm/s). The aim was to explore microcirculatory parameters using the new optical method, integrating DRS and LDF in a joint skin model, during local heating of the dorsal foot and venous and arterial occlusion of the forearm in 23 healthy subjects (age 20-28 years). There were differences in the three speed regions in regard to blood flow changes due to local heating, where perfusion for high speeds increased the most. There was also a high correlation between changes in oxygenation and changes in perfusion for higher speeds. Oxygen saturation at baseline was 44% on foot, increasing to 83% at plateau after heating. The larger increase in perfusion for higher speeds than for lower speeds together with the oxygenation increase during thermal provocation, shows a local thermoregulatory blood flow in presumably arteriolar dermal vessels. In conclusion, there are improved possibilities to assess microcirculation using integrated DRS and LDF in a joint skin model by enabling both oxygenation and speed resolved blood flow assessment simultaneously and in the same skin site. Output parameters in absolute units may also yield new insights about the microcirculatory system.

Key words: diffuse reflectance spectroscopy, laser Doppler flowmetry, microcirculation, skin blood flow, hemoglobin oxygen saturation.