QUANTITATIVE MONITORING OF TISSUE OXYGENATION BY TIME-RESOLVED SPECTROSCOPY

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Near-infrared spectroscopy is now being used in clinical diagnosis as a non-invasive monitor of tissue oxygenation state. However, due to lack of the optical pathlength information within tissues, it is still difficult to quantitate the hemoglobin concentration with present CW techniques. Time-resolved spectroscopy (TRS), which measures temporal profiles of emerging light from tissues, enables to estimate the pathlength distribution within tissues by converting time to distance. Consequently, quantitative measurement of tissue oxygenation is possible by analyzing the data with optical diffusion equation 1) or our Microscopic Beer-Lambert law2).

Time-Resolved Spectroscopy System : TRS-103)

Our TRS-10 system consists of a three-wavelength (759, 797, 833 nm) PLP as pulsed light source, a high speed PMT with high sensitivity and three signal-processing circuits for time-resolved measurement (CFD/TAC, A/D converter and histogram memory). Optical pulse train consisting of 759,797 and 833nm is generated by PLP at 5MHz repetition rate and irradiated a sample through a single optical fiber. The diffuse-reflected light from the sample is collected by a bundle fiber and then detected by the PMT for single photon measurement. After being amplified by a following fast amplifier, the electrical signals for each wavelength are picked out by CFD/TAC module. Then, a signal processing circuit integrated the TRS data for each wavelength individually. The simultaneous TRS measurement for three wavelengths achieved without any optical or mechanical switch.

Experiment and Results

Input and detection fibers of TRS-10 were attached at the human forehead with a fiber separation of 3cm. TRS measurements were continuously performed for about 20 minutes including 2 minutes hyper ventilation. It was observed that the total hemoglobin concentration was decreasing during the hyper ventilation and recovered until 2 minutes after hyper ventilation. On the other hand, the deoxy-hemoglobin concentration began to increase after hyper ventilation and had its peak at around 2 minute later, showing SO2 drop from 75% to 60% due to inhibition of breathing by performing hyper ventilation. The results showed that this system might be able to quantitate the concentrations of oxy- and deoxy-hemoglobin in the human brain.

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