Fluorescence, Diffuse Reflectance and NIR Imaging in Cardiovascular Research and Diagnostics

Gussakovsky E., Kupriyanov V., Sowa M.

Institute for Biodiagnostics, National Research Council Canada
435 Ellice Ave, Winnipeg, Manitoba R3B 1Y6 Canada
Tel. 1-204-984-4501; email: Eugene.Gussakovsky@nrc-cnrc.gc.ca

Three selected topics of VIS-NIR spectroscopy – intrinsic fluorescence, diffuse reflectance and NIR spectroscopic imaging – are combined as related to a multimodal approach in cardiovascular research and diagnostics.

Intrinsic fluorescence of artery tissue (under present consideration) excited and collected with optical fiber probe, has been measured to have a two-band spectrum, which has been proposed to result from hemoglobin-determined reabsorption of emission. When emission/excitation configuration is about 180°, the artery tissue optics provides diffuse reflectance. Both Kubelka-Munk and photon migration (PM) approaches theoretically describe diffuse reflectance, reabsorption and emission tracks in the tissue and were employed to support the reabsorption effect. However, according to direct experiments in the absence of reabsorption shown by diffuse reflectance, the aorta fluorescence is really multi-component. An Alentsev-Fok approach-assisted decomposition revealed three major and a few minor components. The major components are probably related to cross-links in collagen and elastin as well as to NADH. Because number and variation of cross-links are characteristic for atherosclerotic diseases of arteries, their intrinsic fluorescence may serve as a diagnostic tool.

Diffuse reflection appeared to be effective optical approach when biomedical tissue studies with spectroscopic NIR imaging. Diffuse reflectance of a beating heart either *in vivo* or *ex-vivo* is monochromatically collected by CCD camera. To eliminate the heart moving effect, the capture of the image is performing via blood pressure-driven time gates. Such setup allows obtaining pseudo-absorption spectra in the 650-1050 nm range at each of 256×256 pixels during 4 min. The spectra provide information on a quantity of oxygenated and deoxygenated hemoglobin and myoglobin as well as water content. Respectively, heart images of these physiologically important parameters became available. The improvement of this approach allowed (i) simplifying the calculations via application of the first derivative of the spectra and diagonalizing the linear transformation matrix as well as (ii) providing the measurements under sterile conditions and, respectively, a possibility to use the method in hospitals for immediate diagnostics of the heart status at surgeries.

In collaboration with M. Smith, O. Jilkina, Institute for Biodiagnostics, National Research Council Canada.