Fluorescence Spectral Imaging (FSI) Technique as a Probe of Photosensitizer Tissue Distribution

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Progress in antitumor photodynamic therapy depends considerably on the development of advanced photosensitizers (PS), which should have intensive far-red absorption, high quantum yield of reactive oxygen species formation, considerable accumulation in tumor and low toxicity without light-activation. Analysis of PS microdistribution in tissues as a function of time after PS injection (topical or oral application) helps to characterize a selectivity of PS accumulation in tumor cells and other tissue structures; to reveal correctly a maximum of time profile of its tumor accumulation and to recognize the features of PS tissue distribution (spatial and temporal) at different ways of PS application. These data are required to optimize PS application for tumors of different localization, to choose correctly delay time between PS injection and tumor irradiation with light and to understand deeper a tissue response to photodynamic therapy. Comparative study of various PS is important to realize how the differences in molecular properties would affect tissue distribution, tumor accumulation, and, finally, the overall antitumor effect.

PS are fluorescent dyes, and a FSI technique is specifically suitable to solve the tasks listed above. According to the FSI technique a thing tissue section is scanned under microscope, and fluorescence spectra are measured in each point of the specimen with a submicron 3D resolution. It provides an important advantage in comparison with other imaging methods, which measure signal intensity in the filter-selected spectral range, because all spectrum parameters are accessible for an analysis. The spectral analysis allows one to recognize and deconvolve overlapping signals of Rayleigh scattering, intrinsic tissue fluorescence and PS, and finally, to reconstruct spectral images describing a true PS distribution. Moreover, a tissue specificity of the components of complex photosensitizing substances, like Photosens, can be revealed. A software processing of spectral images is used to characterize relative accumulation of PS in various tissue structures identified histochemically.

In this presentation, we report on the advanced FSI technique applications to the study of different PS (Photosens, Alasens, Photofrin) in human malignant tissues.