THE CHANGE IN METABOLISM AND ELECTRIC FIELD INDUCED APOPTOSIS IN CANCEROUS CELLS STUDIED BY FLUORESCENCE LIFETIME MICROSCOPY

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Metabolism is an important life-sustaining biochemical process that supports cellular function through biomolecular interactions and through energy transformations. Consequently, the dysfunction of the metabolic process leads to numerous diseases including cancer. Metabolic dysfunction of cancerous cells can lead to altered microenvironments, resulting in changes in the environment of endogenous fluorophores such as nicotinamide adenine dinucleotide (NADH) and flavin adenine dinucleotide (FAD). Then, monitoring the fluorescence properties of native NADH and FAD in normal and cancerous cells is considered to provide substantial information noninvasively on biochemical and biophysical aspects. In our studies of human lung non-small carcinomas H661 and A549 and normal lung cells MRC-5, the different spectral profiles and the fluorescence lifetime of NADH and FAD were acquired by time-resolved fluorescence spectroscopy including fluorescence lifetime microscopy (FLIM). The fluorescence lifetime of both NADH and FAD were found to be shorter in cancerous cells than in normal cells. The change in lifetime induced by the change in metabolism likely alteres the subcellular environment and potentially affects the interaction of NADH and FAD with the enzymes to which these cofactors are bound [1-2]. The redox ratio of NADH and FAD of cancerous cells was also shown to be larger than that of normal cells.

We also investigated the effects of nanosecond pulsed electric field (nsPEF) on intracellular function in cancerous and normal cells of the same origin/organ. It is shown that the application of nsPEF induces effective change in mitochondrial function in cancerous cells, and the change in function triggers the multiple biochemical events including the disruption of metabolic processes. The disruption of metabolic processes reflects the changes in intensity and lifetime of autofluorescence of NADH. The field-induced change in mitochondrial functional further processes to the caspase dependent apoptosis (cell death), resulting in the morphological changes including cell swelling and/or blebbing [2, 3]. The normal healthy cells remained un- and/or less affected, in contrast with cancerous cells, even when the external electric fields having the same strength and the same frequency were applied.

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