Monitoring Dielectric Properties in Tissue - a Possible Paradigm Shift in Radiation Therapy?

Even though it is widely accepted that the individual's response to radiation is cell specific and heterogeneous, current practices are based on almost uniform fractionated doses. For most cases, even late radiation effects cannot be reliably predicted and the treatment has a very weak feedback. A method to quantify the tissue response to radiation would radically alter conventional treatment norms by allowing the radiation oncologist to tailor treatment to the individual more responsively, based on data collected during the treatment. It is known that the free radicals secondary to ionizing radiation can attack the cell membrane lipid bilayer, possibly leading to cell interphase death. Dielectric properties and conduction mechanisms, intimately related to the self-similar biological structures, are highly sensitive to changes in the overall physiological state and can be used to monitor radiation-induced effects in both healthy and tumor tissue. In this paper we show that α and β dielectric dispersions can be related to radiation induced changes in cell membrane state as well as in extracellular matrix. The α dispersion is mainly due to the extracellular environment, but counterion polarization, membrane conductance and the charging of intracellular membrane bound organelles also contribute. The β dispersion occurs at low radiofrequencies, arising principally from the capacitive charging of cellular membranes in tissues. We are presenting results obtained in irradiated excised mice organs.

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