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Solid-liquid structure model for Ps-based oncological nanodiagnostics

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Solid-liquid structure model for Ps-based oncological nanodiagnostics

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For an aging society, the socio-economic consequences of neoplastic diseases justify research towards developing effective oncological diagnostics. An opportunity for the development of highly sensitive nanodiagnostics is the combination of two technique based on the same annihilation process, the Positron Emission Tomography (PET) and the Positron Annihilation Lifetime Spectroscopy (PALS). While the first imaging technique uses annihilation quanta, the second has been used for decades to determine the structure of materials at nanometer level and based on the hydrogen-like unstable positronium atom (Ps=e^-+e^+).
The biological material still belongs to the group of complex systems that have been poorly investigated using the PALS technique. Due to large morphological and physiological diversity of tissue, different origin of cells, metabolism and functionality, there are a number of factors that affect and disrupt the process of Ps creation and annihilation. On the other hand, the neoplastic processes lead to tissue dysfunction and are associated with changes in both the structure and metabolism of the tissues building the organ.
As a simplification of complex biological system we proposed to adopt a solid-liquid structure model. As a consequence of such approach we could distinguish two types of volumes in which Ps annihilates: the nanobubbles in the liquid phase of the sample (body fluid, mainly water), and the nano-volumes in rigid structure, similar to the solid phase of the sample.
The samples taken from healthy and neoplastic tissues of the human uterus and liver were investigated using PALS technique. The analysis was performed using the solid-liquid structure model. The INTI plot mapping was used to determine the type and degree of neoplastic lesions. The total water content (free and physiosorbed) of healthy and altered tissue was estimated. The possible influence of chemical composition (radicals and O2 concentration) as well as the chemotherapy treatment was discussed.
The observations and the above listed results may be used to develop additional functionality of new generation PET scanners in the field of non-invasive diagnostics accompanying imaging.

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