Positronium life-time as a new approach for cardiac masses imaging

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Background/Introduction: Positron Emission Tomography (PET), also a standard in cardiovascular imaging, enables semi-quantitative myocardial perfusion evaluation and assessment of atherosclerosis. PET is based on positron-electro annihilation inside a patient's body and in about 40% events it proceeds via formation of positronium. Positronium is an exotic atom created from an electron and a positron in a patient during standard PET imaging. Positronium is not stable and its life-time depends on molecular environment. Recently, it was shown that with the new generation of high sensitivity long-axial field of view PET systems is possible to perform simultaneous imaging of the metabolism rate of administered pharmaceutical and imaging of positronium life-time. Positronium life-time informs about tissue nanostructure and allows distinguishing pathology.

Purpose: Purpose of the presented study is the evaluation of positronium life-time as a biomarker for cardiac masses, namely cardiac myxoma (CM) and normal tissues, obtained from symptomatic patients.

Methods: CM and adipose tissue samples were obtained during a surgery from six symptomatic patients with ECHO confirmed cardiac masses in a left atrium. Immediately after sampling, sample were analyzed with the dedicated positronium-life time measurement system. Samples were irradiated with positrons emitted from the 22Na radionuclide. The system enabled to measure the time-difference spectrum between the formation and annihilation of positronium atom within the studied samples. The life-time spectrum was used for the extraction of a mean positronium life-time. The sample underwent histopathological and micro-computer-tomography (micro-CT) examinations, which confirmed a diagnosis and revealed microstructure of a cardiac mass.

Results: It was established that positronium life-time in CM tissues is significantly (at the level of 10 standard deviations) smaller than in adipose tissue. At the same time, the determined positronium life-time in CM samples from different patients was the same within two standard deviations. Micro-CT imaging showed that CM samples had different calcification spots, but did not revealed existing microvasculature.

Conclusion: Obtained results confirm that positronium life-time differentiates between cardiac pathologies (CM) and normal tissues. And may be used as a biomarker in cardiac masses assessment available during PET examination.