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In-vivo double photon emission coincidence imaging of tumor-targeted polymeric micelles

We report a proof-of-concept study applying double-photon emission coincidence imaging (DPECI) to visualize polymeric micelle-based nanocarriers in a tumor-bearing mouse model. The micelles, formed via self-assembly of block copolymers, had an average diameter of approximately 30 nm. They were radiolabeled with DOTA-conjugated ^{111}In and administered intravenously, enabling passive tumor accumulation via the enhanced permeability and retention (EPR) effect.

The DPECI system consisted of 12 high-resolution GAGG(Ce) scintillator arrays with a pixel size of 2.5 × 2.5 × 4 mm^3 and a pitch of 3.2 mm, arranged in an 8 × 8 matrix. Those arrays were optically coupled to a matching 8 × 8 silicon photomultiplier (SiPM) array. A hybrid collimator configuration was employed, comprising a 15 mm-thick parallel-hole collimator (hole diameter: 2 mm, hole pitch: 3.2 mm) and a 15 mm-thick slat collimator (slat pitch: 3.2 mm). Cascade gamma photons at 171 keV and 245 keV emitted from ^{111}In were detected in coincidence and localize the position by intersection of a defined plane by slat collimator and a defined line by parallel hole collimator. SiPM output signals were processed using a dynamic time-over-threshold (dToT) approach, and the time stamp, ToT length, and channel number of each event were simultaneously recorded in a parallelized data acquisition (DAQ) system.

Micelle accumulation was clearly visualized at the tumor region, with distinct separation from background signals and spatial consistency. This study represents the first in vivo application of DPECI to track polymeric nanocarriers with 111In cascade nuclides, highlighting its potential as a reconstruction-free imaging platform for small-animal biodistribution assessment.

Workshop topics

Detector systems

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