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First demonstration of portable Compton camera to visualize 223-Ra concentration for radionuclide therapy

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Radionuclide therapy (RNT) is an internal radiation therapy that can selectively damage cancer cells. Very recently, the use of alpha-emitting radionuclides was initiated in RNT owing to its dose concentration and short range. In particular, 223-Ra is widely used for bone metastasis cancer. Despite its potential for clinical applications, it is difficult to see whether the drug has been properly delivered to the target lesion; thus, large uncertainties remain regarding the optimal dosage for each patient. As such, we propose a new method of monitoring nuclear gamma rays promptly/simultaneously emitted from 223-Ra in alpha-decay by using a high-sensitivity Compton camera. We first observed a small bottle of 223-Ra solution that had a total radioactivity of 0.56 MBq. By selecting gamma lines of 270 and 351 keV, the reconstructed image converged at the correct position with a position resolution of ~20 mm at a plane 10 cm ahead of the camera. Next, we observed a phantom consisting of three spheres, with diameters ranging from 13 to 37 mm, filled with 223-Ra solution (9 kBq/ml) and then surrounded by a ~20-cm layer of water. A 3D image was constructed by rotating the Compton camera around the phantom. Then, images were taken from eight directions at 30-min intervals, respectively. Although the image resolution remains limited at 351 keV, three spheres were resolved at the correct position in the 3D image with their relative intensities. Finally, we discuss current problems and plans for improving the sensitivity and angular resolution for future clinical applications.

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