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Evaluating performance of a pixel array semiconductor SPECT system for small animal imaging

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Objectives: Small animal imaging has recently been focused on basic nuclear medicine. We have designed and built a small animal SPECT imaging system using a semiconductor camera and a newly designed collimator. We assess the performance of this system for small object imaging. ***Methods:*** We employed an MGC1500 (Acrorad Co.) camera including a CdTe semiconductor. The pixel size was 1.4 mm/pixel. We designed and produced a parallel-hole collimator with 20-mm hole length. Our SPECT system consisted of a semiconductor camera with the subject holder set on an electric rotating stage controlled by a computer. We compared this system with a conventional small animal SPECT system comprising a SPECT-2000H scanner with four Anger type cameras and pinhole collimators. The count rate linearity for estimation of the scatter was evaluated for a pie-chart phantom containing different concentrations of ^{99m}Tc. We measured the FWHM of the ^{99m}Tc SPECT line source along with scatter. The system volume sensitivity was examined using a flood source phantom which was 35 mm long with a 32-mm inside diameter. Additionally, an *in vivo* myocardial perfusion SPECT study was performed with a rat. ***Results:*** With regards to energy resolution, the semiconductor camera (5.6%) was superior to the conventional Anger type camera (9.8%). In the count rate linearity evaluation, the regression lines of the SPECT values were $y = 0.019x + 0.031$ ($r^2 = 0.999$) for our system and $y = 0.018x + 0.060$ ($r^2 = 0.997$) for the conventional system. Thus, the scatter count using the semiconductor camera was less than that using the conventional camera. FWHMs of our system and the conventional system were 2.9 ± 0.1 and 2.0 ± 0.1 mm, respectively. Moreover, the system volume sensitivity of our system [0.51 kcps/(MBq/m*l*)/cm] was superior to that of the conventional system [0.44 kcps/(MBq/m*l*)/cm]. Our system provided clear images of the rat myocardium, sufficient for practical use in small animal imaging. ***Conclusions:*** Our SPECT system, utilizing a semiconductor camera, permits high quantitative analysis by virtue of its low scatter radiation and high sensitivity. Therefore, this system may contribute to molecular imaging of small animals and basic medical research.

Key words: semiconductor detectors, small animal imaging, single photon emission computed tomography