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Performance evaluation of a dual Micro-SPECT detector system

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The ability to conduct radiopharmaceutical research in vivo is largely dependent on nuclear imaging hardware and is subject to its limitations. The inability of clinical instrumentation to conduct non-invasive tracer bio-kinetics has spurred the development of dedicated pre-clinical imaging systems such as Micro-SPECT. Pixelated NaI(Tl) detectors are a relatively new attempt to further increase Micro-SPECT viability in conducting longitudinal research. The goal of this experiment is to evaluate a dual pixelated NaI(Tl) gamma-ray Micro-SPECT system and its ability to conduct routine preclinical studies. The SPECT detectors each have an area of 150 mm x 150 mm composed of 4624 (2 mm x 2 mm x 10 mm) NaI(Tl) scintillators coupled to position sensitive photomultiplier tubes. Various tungsten pinhole collimators are used depending on the amount of radioactivity in the SPECT field of view. The Micro-SPECT images are reconstructed using an OSEM routine with sub-voxel capabilities. The sensitivities and efficiencies of the SPECT detectors were determined for Tc-99m and In-111. The practical and optimum SPECT system resolutions were determined using commercial phantoms and evaluated in a Tc-99m-MDP SPECT/CT scan. Longitudinal SPECT/CT studies were performed on tumor bearing models using a receptor targeted radiopharmaceutical at 1, 4, 24, 48 and 72 hours post injection. System sensitivities of 340 cps/MBq and efficiencies of 0.03% were achieved at 25 mm from the 2 mm pinhole aperture. The spatial resolution of the SPECT was determined to optimally be 1.6 mm and practically 2.4 mm using a hot-rod reconstructed Tc-99m phantom scanned for 16 hours and 30 minutes respectively. Bone and tumor SPECT studies revealed excellent target tissue/organ visualization. Longitudinal Micro-SPECT/CT studies were conducted successfully over a 72 hour period post injection. These findings suggest that pixelated NaI(Tl) detector technology is capable of repeated imaging in the same subject.