

Purpose: Small animal microSPECT is an important pre-clinical imaging modality. However, the quantitative accuracy is limited by photon attenuation in the subject and scatter in the subject and the collimator. In this study we investigate correcting for both scatter and attenuation in the reconstruction of a small animal sized phantom.

Methods: A phantom consisting of a cold centre surrounded by a hot shell, surrounded by an outer layer of either water or air, was scanned in a multiplexing multi-pinhole (MMP) SPECT scanner. Scan parameters were as follows: 9 pinholes/detector, 2.5 mm diameter; 48 projections; helical scan; 3 minutes per projection. Projection data was recorded for two energy windows, one centered at the photopeak (140 keV) and a second window below the photopeak centered at 110 keV. The phantom was also scanned with the built-in CT scanner (45 keV, cone beam) and reconstructed using filtered backprojection. The SPECT data were reconstructed using an iterative ordered subsets expectation maximization (OSEM) algorithm with no correction, attenuation correction (AC) only, and both scatter (SC) and AC. Attenuation was estimated from the CT and incorporated into the system matrix as part of the reconstruction. Scatter was estimated using the dual energy window method and subtracted from the projections prior to reconstruction. Absolute quantification was derived from a scan of a point source with known activity.

Results: With attenuation and scatter correction, the measured activity concentrations in the hot region of the phantom were within 12% of the true value with the external chamber of the phantom both full and empty. Scatter correction in addition to AC improves the accuracy over AC alone in the cold regions.

Conclusions: Attenuation correction significantly reduces the subject-size dependence of the quantitative accuracy in small-animal MMP SPECT. Scatter correction may provide some additional benefit.

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