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Performance evaluation of OSEM reconstruction algorithm incorporating three-dimensional distance-dependent resolution compensation for brain SPECT: A simulation study

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Iterative reconstruction techniques such as an ordered subsets-expectation maximization (OSEM) algorithm can easily incorporated various physical models of attenuation or scatter. We implemented OSEM reconstruction algorithm incorporating compensation for distance-dependent blurring due to the collimator in SPECT. The algorithm was examined by computer simulation to estimate the accuracy for brain perfusion study. ***Methods:*** The detector response was assumed to be a two-dimensional Gauss function and the width of the function varied linearly with the source-to-detector distance. The attenuation compensation (AC) was also included. To investigate the properties of the algorithm, we performed computer simulations with the point source and digital brain phantoms. In the point source phantom, the uniformity of FWHM for the radial, tangential and longitudinal directions was evaluated on the reconstruction image. As for the brain phantom, quantitative accuracy was estimated by comparing the reconstructed images with the true image by the mean square error (MSE) and the ratio of gray and white matter counts (G/W). Both noise free and noisy simulations were examined. ***Results:*** In the point source simulation, FWHM in radial, tangential and longitudinal directions were 14.7, 14.7 and 15.0 mm at the image center and were 15.9, 9.83 and 10.6 mm at a distance of 15 cm from the center by using FBP, respectively. On the other hand, they were 8.12, 8.12 and 7.83 mm at the image center, and were 7.45, 7.44 and 7.01 mm at 15 cm from the center by OSEM with distance-dependent resolution compensation (DRC). An isotropic and stationary resolution was obtained at any location by OSEM with DRC. The spatial resolution was also improved about 6.5 mm by OSEM with DRC at the image center. In the brain phantom simulation, the blurring at the edge of the brain structure was eliminated by using OSEM with both DRC and AC. The G/W was 2.95 and 2.68 for noise free and noisy cases, respectively, when no compensation was performed. But the values for G/W without and with noise became 3.45 and 3.21 with AC only and were improved to 3.75 and 3.71 with both AC and DRC. The G/W approached the true value (4.00) by using OSEM with both AC and DRC even when there was statistical noise. ***Conclusion:*** In conclusion, OSEM reconstruction including the distance-dependent resolution compensation algorithm was reasonably successful in achieving isotropic and stationary resolution and improving the quantitative accuracy for brain perfusion SPECT.

Key words: single photon emission computed tomography (SPECT), distance-dependent blurring, collimator, ordered subset-expectation maximization (OSEM), resolution compensation