Application of Unregularized OSEM with 3D Detector Response to I−131 SPECT with Ultra−High− and High−Energy Collimation.

K. F. Koral, Q. Lin, A. Yendiki, A. Akhtar, Y. K. Dewaraja, J. A. Fessler,
University of Michigan Medical Center, Ann Arbor, MI and University of Michigan Dept. of Electrical Engineering and Computer Science, Ann Arbor, MI.

Objectives: Evaluate unregulaized OSEM reconstruction with a three dimensional detector response for 131−I SPECT using a high−energy collimator (HE), or an ultra−high (UHE) variation (septal−wall−thickness equal to 1.73 or 3.43mm). **Methods:** With both collimators and a Picker Prism camera, images were acquired for: 1) a point source at five depths from 2 to 24.5cm, 2) a 200 cc sphere in a water−filled elliptical phantom using a circular SPECT orbit of radius r. Cylinder−over−sphere activity−concentration ratio, b, was varied from 1 to 1/2. With r=26cm, SPECT projection data for spheres from 200cc to 20cc were simulated for the UHE by Monte−Carlo. Similar simulations with the HE are in progress. The 3D OSEM employed attenuation correction based on a map from registered CT, and utilized a scatter−estimate image from triple energy windows. **Results:** With the UHE: the point source images at all depths were well fit with a two−dimensional Gaussian. The FWHM increased linearly with depth. With b=1/4 and r=23cm, the count total within the 200cc sphere converged after 20 iterations (less than 0.52% increase from 8 to 20). So 20 iterations was used thereafter. For r=19, 23, and 26cm, the counts−to−activity conversion factor was effectively independent of b. With b=0, sphere activity was almost constant down to 20cc. With b=1/5, the values were noisy, (7.2mm being too large a pixel size), but fell off at the smallest volume (value at 20cc 0.83 times that at 200). With the HE: due to septal penetration an exponential tail had to be added to the Gaussian to fit the point−source images. The FWHM and the length of the tail both increased linearly with depth, while the amplitudes decreased. The latter were well fit by a power function. More than 50 iterations were necessary to approach convergence, because of the large size of the 3D depth−response matrix. Further characteristics of the HE will be investigated. **Conclusions:** The 3D unregularized OSEM converges slowly with the HE (but this may not be critical for therapy studies). It is effective for quantitative 131−I SPECT, at least with the UHE.