Implementation and Performance Evaluation of Depth-Dependent Correction in SPECT for Myocardial Numerical Phantom: A Simulation Study Using EGS4

Takeyuki Hashimoto 1), Toshikazu Imae 2), Daisuke Usuba 2), Toshihiro Momose 3), Hiroyuki Shinohara 2) ,Takashi Yokoi 4)

1) Dept. of Information Science, Yokohama Soei College

2) Dept. of Radiological Science, Tokyo Metropolitan University of Health Science

3) Dept. of Radiology, JR Tokyo Hospital

4) Bioimaging Laboratory, Inc

A single-photon emission computed tomography (SPECT) system detects gamma rays emitted by a radioactive source. This SPECT reconstruction has three famous problems which are attenuation, scatter and depth-dependent detector response. We are able to obtain the projection data of myocardial numerical phantom for SPECT which have three above - mentioned problems using EGS4. Especially, EGS4 is able to generate the projection data without scattor. The iterative maximum likelihood expectation maximization (ML-EM) image reconstruction method and frequency-distance relation (FDR) are using to correct the depth-dependent detector response. ML-EM algorithm has become available as an alternative to filtered back projection in SPECT. This algorithm is able to include both attenuation correction and depth-dependent correction. On the other hand, FDR algorithm is for depth-dependent correction. In this study, we demonstrate three methods of the depth-dependent correction of SPECT myocardial numerical phantom. The projection data of this phantom with non-uniform attenuation and depth-dependent detector response was generated from EGS4. The simulated radioisotope was Tc-99m (photon energy is 140keV). First method is using ML-EM algorithm for reconstruction, attenuation correction and depth-dependent correction. Second method is using FDR algorithm for depth-dependent correction and using ML-EM algorithm for reconstruction and attenuation correction. FDR is non-iterative algorithm that it is able to combine with the other reconstruction methods. So that, third method is using FDR algorithm for depth-dependent correction and using the analytical reconstruction of SPECT for attenuation correction. Each reconstruction images are compared with the original image. We observed that first method is the best performance. Iterative ML-EM reconstruction algorithm is effective in compensating for non-uniform attenuation distribution and depth-dependent detector response, simultaneously. We should keep in mind which method is being used and its computational details, when clinical usefulness are compared.