

Correction of nonuniform attenuation and image fusion in SPECT imaging by means of separate X-ray CT

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Improvements in image quality and quantitation measurement, and the addition of detailed anatomical structures are important topics for single-photon emission tomography (SPECT). The goal of this study was to develop a practical system enabling both nonuniform attenuation correction and image fusion of SPECT images by means of high-performance X-ray computed tomography (CT). A SPECT system and a helical X-ray CT system were placed next to each other and linked with Ethernet. To avoid positional differences between the SPECT and X-ray CT studies, identical flat patient tables were used for both scans; body distortion was minimized with laser beams from the upper and lateral directions to detect the position of the skin surface. For the raw projection data of SPECT, a scatter correction was performed with the triple energy window method. Image fusion of the X-ray CT and SPECT images was performed automatically by auto-registration of fiducial markers attached to the skin surface. After registration of the X-ray CT and SPECT images, an X-ray CT-derived attenuation map was created with the calibration curve for ^{99m}Tc . The SPECT images were then reconstructed with scatter and attenuation correction by means of a maximum likelihood expectation maximization algorithm. This system was evaluated in torso and cylindrical phantoms and in 4 patients referred for myocardial SPECT imaging with Tc-99m tetrofosmin. In the torso phantom study, the SPECT and X-ray CT images overlapped exactly on the computer display. After scatter and attenuation correction, the artifactual activity reduction in the inferior wall of the myocardium improved. Conversely, the increased activity around the torso surface and the lungs was reduced. In the abdomen, the liver activity, which was originally uniform, had recovered after scatter and attenuation correction processing. The clinical study also showed good overlapping of cardiac and skin surface outlines on the fused SPECT and X-ray CT images. The effectiveness of the scatter and attenuation correction process was similar to that observed in the phantom study. Because the total time required for computer processing was less than 10 minutes, this method of attenuation correction and image fusion for SPECT images is expected to become popular in clinical practice.

Key words: nonuniform attenuation correction, image fusion, image registration, single-photon emission tomography, X-ray computed tomography