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Usefulness of noise adaptive non-linear Gaussian filter in FDG-PET study

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Objective: In positron emission tomography (PET) studies, shortening transmission (TR) scan time can improve patient comfort and increase scanner throughput. However, PET images from short TR scans may be degraded due to the statistical noise included in the TR image. The purpose of this study was to apply non-linear Gaussian (NLG) and noise adaptive NLG (ANLG) filters to TR images, and to evaluate the extent of noise reduction by the ANLG filter in comparison with that by the NLG filter using phantom and clinical studies. ***Methods:*** In phantom studies, pool phantoms of various diameters and injected doses of 2-deoxy-2-[^{18}F]fluoro-D-glucose (FDG) were used and the coefficients of variation (CVs) of the counts in the TR images processed with the NLG and ANLG filters were compared. In clinical studies, two normal volunteers and 13 patients with tumors were studied. In volunteer studies, the CV values in the liver were compared. In patient studies, the standardized uptake values (SUVs) of tumors in the emission images were obtained after processing the TR images using the NLG and ANLG filters. ***Results:*** In phantom studies, the CV values in the TR images processed with the ANLG filter were smaller than those in the images processed with the NLG filter. When using the ANLG filter, their dependency on the phantom size, injected dose of FDG and TR scan time was smaller than when using the NLG filter. In volunteer studies, the CV values in the images processed with the ANLG filter were smaller than those in the images processed with the NLG filter, and were almost constant regardless of the TR scan time. In patient studies, there was an excellent correlation between the SUVs obtained from the images with a TR scan time of 7 min processed with the NLG filter (x) and those obtained from the images with a TR scan time of 4 min processed with the ANLG filter (y) ($r = 0.995$, $y = 1.034x - 0.075$). ***Conclusions:*** Our results suggest that the ANLG filter is effective and useful for noise reduction in TR images and shortening TR scan time while maintaining the quantitative accuracy of FDG-PET studies.

Key words: positron emission tomography, 2-deoxy-2-[^{18}F]fluoro-D-glucose, non-linear Gaussian filter, noise adaptive non-linear Gaussian filter, transmission scan