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Tc99m contrast recovery, scatter and PSF correction techniques of the Spectrum Dynamics Veriton SPECT-CT

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Objective

Using our methodology previously developed for a comparison of several SPECT-CT systems [1], we investigated the hot and cold contrast recovery of the Spectrum Dynamics Veriton 200 SPECT-CT when its various scatter correction and resolution recovery methods were applied.

Method

Two phantoms filled with about 740 MBq of ^{99m}Tc were used: a NEMA NU-2 1994 scatter phantom and a 20-cm diameter contrast cylindrical phantom with a uniform compartment and 85-mm tall rods, seven cold in a hot background and seven hot in a cold background. Concentration was identical in all radioactive part. The Veriton was operated with its focused mode, 4 orbits (2.46 mm pixels) and the factory default energy windows for scatter correction with ^{99m}Tc.

Iterative reconstructions with CT-based attenuation correction were performed using the constructor algorithm. Additional corrections (AdC) for scatter and PSF were compared: dual energy window (DEW), so-called PSF quantitative (PSFq) and PSF display (PSFd). MLEM equivalent (OSEM iteration times subset number) iterations (ITER) were varied from 48 to 240.

NEMA phantom images were processed as described in NEMA NU-2 (1994) to get the residual fraction (RF) in air, water and Teflon. Cylindrical ROIs of 30-mm height and the rod full (ROIF) or half (ROIH) physical diameter were drawn on the images of the contrast phantom and also a large cylindrical ROI in its uniform part. Mean count per pixel (C) was computed in ROIs and also standard deviation (SD) in the large ROI. Recovery coefficient (RC) was computed as $C_{rod}/C_{uniform}$ for hot rods and $1- C_{rod}/C_{uniform}$ for cold rods. Coefficient of variation (COV) in the uniform part was $SD/ C_{uniform}$.

Results

RF decreased when ITER increased, was similar with PSFq or no AdC, was lower but almost identical with DEW, PSFd and PSFq+DEW.
RC increased with ITER and rod diameter. Cold RC were identical without AdC or with PSFq, larger but identical with DEW, PSFd and PSFq+DEW. Hot RC were very similar without AdC or with DEW, PSFq and PSFq+DEW but considerably higher with PSFd, particularly in ROIH where values amounting 200% were observed. Hot RC versus rod diameter curves showed outlier points for some diameters leading to a suspicion of Gibbs artefacts.
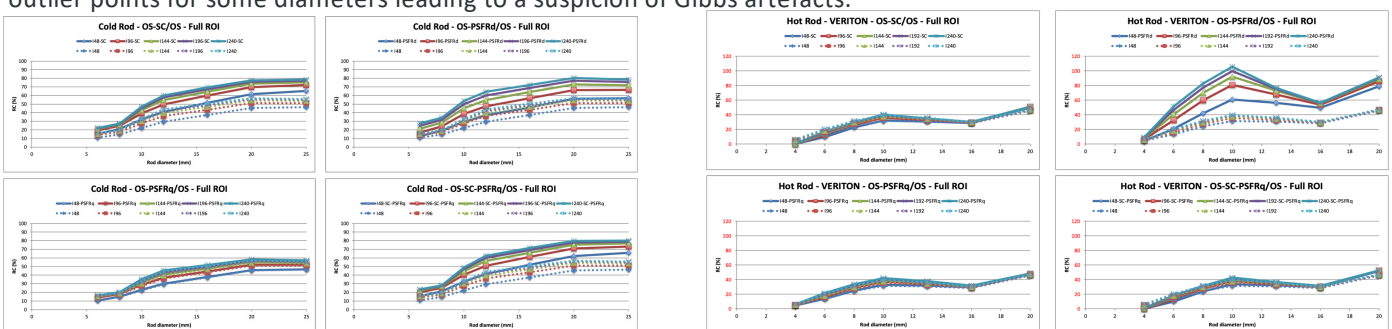

Figure 1. Cold and hot contrast for the Spectrum Dynamics Veriton 200 SPECT-CT using constructor standard iterative reconstruction with attenuation correction and optionnal scatter correction (DEW) and resolution recovery (PSFd, PSFq).

COV increased moderately with ITER and was in the order: no AdC < PSFq < DEW < PSFq+DEW << PSFd.

Conclusion

The Veriton software offers several scatter and resolution correction methods. The PSF display (PSFd) resolution recovery method should be used for visualisation purpose only.

References

[1] Seret A, Bernard C, Nguyen D. Quantitative capabilities of four state-of-the-art SPECT-CT cameras. EJNMMI Research 2012, 2 :45.