Title

PSF correction and Tc-99m quantitative performance of a disruptive CZT multiple-head SPECT-CT

Nr.

EP-0629

Keywords / Topics

++D11 SPECT and SPECT/CT

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Aim

A methodology developed for a comparison of NaI SPECT-CT [1] was used to analyze the quantitative potentialities of a CZT multiple-head SPECT-CT.

Materials and Methods

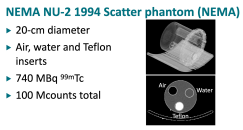
Phantoms: NEMA NU-2 1994 scatter (Figure 1), 9.4-cm (L) and 20-cm (XL) diameter cylinder. The last one was also converted in a contrast phantom (TOM) with two inserts, one with cold rods and the other with hot rods, while leaving a uniform compartment (Figure 2). A grid was also present in this phantom but not used in this study. They were filled with 730-860 (360 for L) MBq of Tc99m and concentration was identical in all radioactive part.

Acquisitions: Veriton 200, Focus mode, 4 orbits, 100 (85 for L) Mcounts, 2.46-mm pixels, WEHS collimator, factory default energy windows.

Reconstructions: OSEM, CT-based attenuation, resolution recovery, optional scatter correction (SC) with dual-energy window, additional PSF recovery so-called

quantitative (PSFRq) or display (PSFRd), OSEM iterations times subset number (*ITER*) from 40 to 240.

Processing: NEMA NU-2 1994 methodology was followed to get the residual fraction (*RF*) in air, water and Teflon inserts of NEMA phantom. Cylindrical ROIs of about 35% of the physical rod height and rod full (FROI) or half (HROI) physical diameter (*d*) were drawn on the CT images of TOM together with a large cylindrical ROI in the uniform part. Mean ROI counts per pixel (*C*) was computed 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 $SD/C_{uniform}$. Calibration factor (*CF*) were obtained from L and XL phantoms using large cylindrical ROIs and applied to *C* of TOM uniform part and NEMA radioactive area.



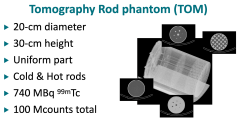


Fig. 1: Figure 1. NEMA phantom

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Fig. 2: TOM phantom.

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Results

RF decreased when ITER increased, was 5.5-10% without SC and 0-2% with SC (Figure 3).

RC increased with *ITER* and rod diameter. For cold rods (Figures 4 & 5), a plateau was reached for $d \geq 20$mm at (FROI/HROI): 56/68%, 79/95% (SC), 57/70% (PSFRq), 80/97% (PSFRq+SC), 79/89%(PSFRd). Up to 10mm hot rods (Figures 6 & 7), *RC* increase was steep and then *RC* fluctuated with a maximum at $d = 20$mm (FROI/HROI): 47/74%, 51/88% (SC), 49/77% (PSFRq), 52/88% (PSFRq+SC), 91/209% (PSFRd).

COV increased almost linearly with ITER (Figure 8): 4.7-6.8%, 5.9-8.6% (SC), 5.1-7.3% (PSFRq), 6.3-9.3% (SC+PSFRq), 11.6-16.1% (PSFRd).

Quantification error (SC and SC+PSFRq) depended moderately on the phantom and

ROI size used to obtain *CF* and was in the range [-2.5,3.4]% for TOM and [-5.4,2.9]% for NEMA.

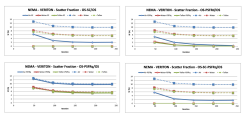

Fig. 3: Figure 3. RF in the three cold (Air, Water and Teflon) inserts of NEMA phantom for iterative reconstruction (OS). SC = scatter correction, PSFRq = quantitative PSF recovery, PSFRd = display PSF recovery.

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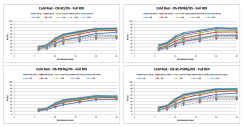

Fig. 4: Figure 4. RC of cold rods of TOM phantom for full ROIs and iterative reconstruction (OS). SC = scatter correction, PSFRq = quantitative PSF recovery, PSFRd = display PSF recovery.

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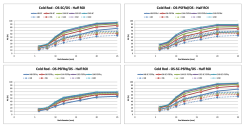

Fig. 5: Figure 5. RC of cold rods of TOM phantom for half ROIs and iterative reconstruction (OS). SC = scatter correction, PSFRq = quantitative PSF recovery, PSFRd = display PSF recovery.

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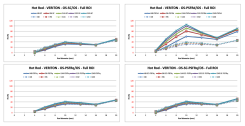

Fig. 6: Figure 6. RC of hot rods of TOM phantom for full ROIs and iterative reconstruction (OS). SC = scatter correction, PSFRq = quantitative PSF recovery, PSFRd = display PSF recovery.

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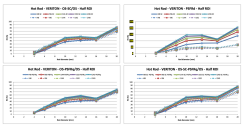

Fig. 7: Figure 7. RC of hot rods of TOM phantom for half ROIs and iterative reconstruction (OS). SC = scatter correction, PSFRq = quantitative PSF recovery, PSFRd = display PSF recovery.

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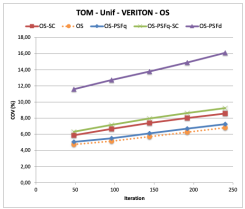

Fig. 8: Figure 8. COV in uniform part of TOM phantom for iterative reconstruction (OS). SC = scatter correction, PSFRq = quantitative PSF recovery, PSFRd = display PSF recovery.

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Conclusion

SC or PSFRq increased contrasts but moderately for hot rods. SC or PSFR increased COV. PSFd should be restricted to visualization purpose.

References

1. Alain Seret, Daniel Nguyen and Claire Bernard. Quantitative capabilities of four state-of-the-art SPECT-CT cameras. EJNMMI Research 2012, 2:45. http://www.ejnmmires.com/content/2/1/45

Prof. Seret Alain Eudore

Disclosure - 1 I or one of my co-authors receive support from a pharmaceutical, device or biotechnology company. If yes, please specify name/position/company/which project and whether support is in kind or monetary:

Support from Stella Martina (StarGuide Belgian Customer Support - GE Healthcare) for operating another CZT camera.

Disclosure - 2 I or one of my co-authors have written articles for (radio)pharmaceutical, medical device, biotechnology or consulting companies during the last 5 years. If yes, please specify name/position /company/article/ journal and co-authors:

Nothing to declare

Disclosure - 3 I or one of my co-authors hold property rights/patents for (radio)pharmaceuticals, medical devices or medical consulting firms. If yes, please specify name/position/company:

Nothing to declare