First Latin-American Congress
on Solid State Dosimetry and Radiation Measurements
13-17 September, 2021

INFLUENCE OF BPL-BASED RECONSTRUCTION ALGORITHM ON IMAGE QUALITY FOR QUANTITATIVE ^{90}Y-PET IMAGING

CARIBÉ, P.R.R.V[1,2], BONIFÁCIO, D.A.B.[4], CORDEIRO, L.P.[3], MARQUES da SILVA, A.M.[2]

[1]Medical Imaging and Signal Processing (MEDISIP), Ghent University, Ghent, Belgium, Paulo.Caribe@UGent.be
[2]Medical Image Computing Laboratory (MEDICOM), PUCRS, Porto Alegre, Brazil
[3]Institute of Radioprotection and Dosimetry (IRD/CNEN), Barra da Tijuca, Rio de Janeiro, Brazil
[4]Nuclear Research and Energy Institute (IPEN/CNEN), Cidade Universitária, São Paulo, Brazil

Introduction: PET/CT technology and image reconstruction algorithms are constantly being improved. This leads to changes in the resulting images which need to be tested and clinically validated. This study evaluated the performance and clinical use of the Bayesian Penalized-Likelihood (BPL) reconstruction algorithm on the state-of-the-art SiPM-based PET/CT for quantitative ^{90}Y-PET imaging.

Method: An image quality (IQ) phantom with an 8:1 hot sphere-to-background ratio was scanned on a GE Discovery MI 3-rings PET/CT system during a single bed scan. ^{90}Y acquisition time was 14h and 20 min (representative for clinical count statistics) for an activity concentration of 218 kBq/ml. Reconstructions were performed using: 3-iterations OSEM algorithm with 16 subsets and Gaussian post-filter FWHM ranging from 4.5 to 10 mm; BPL-based algorithm employing a block sequential regularized expectation maximization (BSREM) with Beta parameter varying from 300 to 3000. Time-of-flight and point-spread function modellings were included in all reconstructions. Contrast recovery (CR), background noise levels (coefficient of variation, COV), contrast-to-noise ratio (CNR) and metabolic tumour volume (MTV) were compared to investigate whether the BSREM reconstruction algorithm leads to an improvement in clinical image quality using ^{90}Y.

Results: The results for CR versus background COV of the IQ phantom are shown in Fig. 1. All plots show a similar trend: CRs values were as expected with higher CRs for lower β and post-filter FWHM values. The Contrast-to-noise ratio was significantly better in BSREM reconstructions when compared with OSEM in phantom studies. In terms of CR mapping, a BSREM β of 1000 corresponded to 5-6 mm post-filter for TOF-OSEM. Regarding noise characteristics of the 14h data, BSREM outperformed TOF-OSEM reconstructions in terms of noise levels with a 2-3 times lower background COV and improved SUV_{mean} and MATV values for all spheres sizes. Lowering the counts for 20 min data, BSREM noise reduction can be controlled by increasing the β-parameter, but caution should be taken to avoid losing CR information. An optimal range of 1500-3000 β values, can provide a compromise between noise and CR at clinical count statistics.

Conclusions: Based on a quantitative phantom study, the BPL-based reconstruction algorithm improves image quality and allows better noise characteristics for ^{90}Y acquisitions when compared to OSEM reconstructions. BSREM reconstructions substantially improved contrast-to-noise ratio and MATVvalues for longer ^{90}Y measurements with better count statistics. For clinically relevant count statistics, BSREM with β values lower than 500 had a limited impact on noise levels of ^{90}Y-PET.

The potential improvements of BPL applied to dosimetry calculations are currently being investigated to determine if BSREM can be used to avoids accuracy degradation in the absorbed dose distribution aiming at patient comfort.

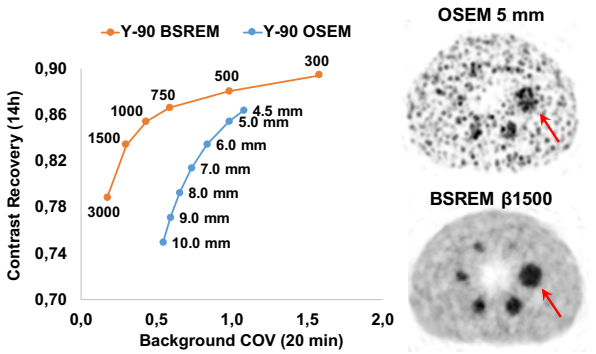

Figure 1 *Right*: Contrast recovery of BSREM (β300–3000) and OSEM 3it/16sub, and FWHM (4.5–10 mm) of the full 14h scan time as a function of the COV of the 20 min acquisition time. *Left*: Qualitative evaluation of the transaxial images of the NEMA phantom of 20 min of acquisition time. The background level is 218 kBq/ml, a contrast ratio of 8:1 and the CR of the sphere 37 mm is showing in all cases.