Title: Standardization and optimization of reconstruction parameters that impact image quality and quantification of PET/CT images

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Background: PET/CT imaging is an essential tool in diagnosis, staging, restaging, treatment response evaluation and recurrence in oncology. Image reconstruction methods produce significant variations in quantification and uptake in small lesions especially for low tumor-to-background ratio. Clinical protocols should aim to optimize image quality and detectability with accurate quantification, and as such, reconstruction protocols should be standardized and optimized.

Objective: The overall goal of this study is assessment of the impact of reconstruction protocols on image quality and quantitative values as obtained from PET/CT images.

Methods: Data acquisition was performed for the IQ-NEMA phantom with signal-to-ground (SBR) ratios of 4:1, 6:1, 8:1 and 10:1 on a Siemens Biograph 6 TrueV PET/CT scanner. Raw PET data was reconstructed using different values of sub-iterations and various Gaussian post-smoothing filters. In addition, image reconstruction was performed using attenuation and scatter correction with and without resolution recovery (PSF modeling). CNR, contrast and noise were measured in order to assess image quality. RC_{max}, $RC_{50\%}$ and RC_{peak} were calculated to enable standardization and optimization of quantitative values, and were compared with the EARL specification reference values.

Results: Though contrast improved by utilizing less smoothing and increasing sub-iterations, CNR and COV were improved using smoother filters and fewer sub-iterations. COV was less than cutoff (15%) for all reconstructions beyond 180sec. Setting the number of iterations to a range between 30 to 60 with post-smoothing of 6 mm FWHM Gaussian filter harmonized quantitative PET data. There were no differences in RC curves between OSEM and PSF in SBR 4:1, but when using PSF, RCmax and RCA50% were overestimated for higher SBRs and for higher iterations. PSF based reconstruction introduced positive bias in RCmax and RCA50% for 13, 17, 22mm spheres in addition to edge artifacts. Applying suitable FWHM Gaussian filters or using RCpeak may reduce the aforementioned bias.

Conclusion: Among the parameters that affect SUV accuracy, reconstruction algorithms play an important role especially in high tumor-to-background ratios. Image quality and detectability in PET images strongly depend on reconstruction parameters and post-smoothing filter. An optimized post-reconstruction filter was found to minimize variations of RC in comparison to EARL references.

Keywords: Optimization, image reconstruction, recovery coefficient, contrast, CNR