Title: Impact of imaging context and duration as well as reconstruction algorithms on measured PET spatial resolutions

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Background: Spatial resolution in PET imaging is a major determinant of performance and image interpretation in oncology.

Objective: The present study aims to assess the impact of acquisition time, different iterative reconstruction protocols (PSF and/or TOF) as well as image context (including contrast levels and background activities) on the measured spatial resolution in PET images.

Methods: Discovery 690 PET/CT scanner was used to study spatial resolution measurement in terms of Full Width Half Maximum (FWHM) as derived (i) directly from capillary tubes embedded in air and (ii) indirectly from 10 mm diameter sphere of the NEMA phantom. To do this, 2 MBq of 18F-FDG was utilized for seven capillary tubes in different scanner FOV. The spheres with 10, 17 and 28 mm diameter of NEMA phantom were also filled with ^{18}F-FDG solution. Different sphere-to-background ratios (2:1, 4:1 and 8:1), background activity levels (2.38 and 4.78 kBq/ml) and acquisition times were also applied. The emission data were reconstructed with iterative reconstruction protocols (PSF and/or TOF). Various combinations of iterations and subsets (it×sub) and post smoothing filter was also evaluated. Relative differences (%) were calculated for assessment of measured FWHM in different protocols.

Results: For capillary tubes embedded in air, the higher it×sub yielded the smaller FWHM values with more impact for PSF algorithms (OSEM+PSF and OSEM+PSF+TOF) relative to non-PSF algorithms (OSEM and OSEM+TOF). Moreover, using post smoothing filter introduced degradations in spatial resolution with more impact for higher it×sub values. For the NEMA phantom, by increasing acquisition times from 1min to 5min, intrinsic FWHM for it×sub=32(54) was improved by 15.3% (13.2%), 15.1% (13.8%), 14.5% (12.8%) and 13.7% (12.7%) for OSEM, OSEM+PSF, OSEM+TOF and OSEM+PSF+TOF, respectively. Furthermore, for all reconstruction protocols and both low and high background activities, the FWHM values improved with more impact for higher it×sub.

Conclusion: Our results indicate that PET spatial resolution is greatly affected by SBR, background activity and the choice of the reconstruction protocols. In addition, PSF algorithms yielded more improved FWHM relative to non-SPF algorithms for higher it×sub and SBRs. For a given reconstruction protocol and it×sub, acquisition times ≥3 min lead to approximately the same spatial resolution values.

Keywords: Positron emission tomography, FWHM, spatial resolution, iterative reconstruction; TOF, PSF.