AbstractID: 11065 Title: Quantitative PET imaging of heterogeneous tumors: The influence of patient position on recovered activity

Purpose:

Dose-painting will require precise quantification of uptake within sub-regions of heterogeneous tumors. We have measured and characterized the effect of patient positioning on heterogeneity within PET images for 2D and 3D acquisition.

Methods and Materials:

Position-dependent variations in recovery coefficients (RC) were measured on a multi-slice PET imaging system using a phantom of five ^{18}F-filled spheres: two10mm and 15mm diameter, one 5mm. Spheres of each size were repositioned in 1mm increments between acquisitions while two kept stationary. 2D and 3D coincident counts were acquired at 4 minutes-per-position, and images generated with iterative reconstruction protocols. Measured RC variations were used to calculate expected SUV changes within heterogeneous tumors, for patient positions sampled from distributions of axial, radial, and angular uncertainties associated with head and neck (HN) cancer.

Results:

For sub-voxel shifts in axial direction, the peak-to-trough RC values (RC_{PT}) in 2D mode were 41%, 8% for 5mm and 10mm diameter sub-regions. In 3D mode, these axial RC_{PT} values were 24% and 7%. RC_{PT} for radial shifts were 31% and 14% for images acquired in 2D mode, and 37% and 12% for 3D acquisition. All RC_{PT} for15mm spheres were within the noise background, as determined from measurements of the stationary spheres.

Random adjustments of head position resulted in notable changes in visual appearance and spatial distribution within PET images. For a very heterogeneous HN tumor, estimated population correlation coefficient between images was 0.8 (n = 1000 images x 696 voxels). However, correlation between individual images ranged from 1.0 to 0.6.

Conclusion:

Reproducibility is necessary for quantitative PET imaging; stable and precise voxel values will result in reliable voxel-based image analysis. However, sub-voxel verification of position of tumor sub-regions is impossible, so shift-interpolated images, which correspond to more reproducible mean RC values, could potentially reduce this systematic uncertainty.