AbstractID: 1222 Title: 4D PET: Quantitative Validation

Breathing motion yields significant challenges for radiation therapy. For positron emission tomography (PET) it distorts the shape of the tumor and degrades small lesion detection. We are developing a process to use our 4D CT imaging technology to map the tumor motion during free breathing and subsequently use the motion maps to remove breathing motion artifacts, including blurring and reduction of target-to-background ratios (T/B) in PET images. The PET scanner will be gated for subsequent reconstruction as a function of breathing cycle. The voxel locations in the gated PET scans will be remapped into reference locations, producing a motion artifact-free image that has the same statistical precision as a static target. Phantom validation of this process was conducted using a cylindrical phantom filled with ^{18}F solution and three spherical target phantoms of 1.0, 2.0, and 3.0 cm diameter filled with ^{11}C solution with initial activities of 0.33 mCi ml^{-1} and 4.59 mCi ml^{-1}, respectively. The different half-lives provided a range of T/B. The phantom was moved under computer control with 1.0 and 2.0 cm amplitudes (alternating each 10-minute long scan) with 5 s periods and the PET scanner synchronously gated to 10 time-points between cycles. The image thresholds (T/B) required to accurately reproduce the target volumes using the motion corrected scans were nearly independent of the target activity and motion magnitude. This threshold as applied to the non motion-corrected images yielded incorrect volumes. Accurate motion modeling will be critical to the quantitative use of PET for lung-tumor treatment planning.