AbstractID: 8587 Title: Evaluation of combined effects of target size, background activity, and respiratory motion on 3D and 4D PET/CT images

Introduction: In recent years, quantitative analysis of gated (4D) PET/CT images has been introduced for diagnosis, staging, and prediction of tumor response where internal organ motion is significant. However, the best methodology for applying 4D information to radiotherapy target definition is not currently well established. In order to accurately determine moving target volume, we have investigated the combined effects of target size, respiratory motion, target-to-background activity concentration ratio (TBR) on ungated (3D) and 4D PET images as well as gating methods.

Materials and Methods: Using a GE Discovery PET/CT scanner, a 3D-PET scan corrected with a 3D attenuation map from 3D-CT scan and a 4D-PET scan corrected with matching attenuation maps from 4D-CT were performed using spherical targets (0.5–26.5 mL) filled with ^{18}F-FDG in a NEMA IEC body phantom at different TBRs (infinite, 8, and 4). To simulate respiratory motion, the phantoms were driven sinusoidally in the *superior-inferior* direction with amplitudes of 0, 1, and 2 cm and a period of 4.5 s. Recovery coefficients were determined on PET images. In addition, gating methods using different numbers of gating bins (1–20 bins) were evaluated by determining image noise and temporal resolution.

Results: Signal loss in 3D-PET images was measured from both the partial volume effect, due to the limited PET resolution, as well as respiratory motion. The results show that signal loss depends on both the amplitude and shape of respiratory motion. However, 4D-PET successfully recovers most of the loss induced by respiratory motion. The 5-bin gating method gives the best temporal resolution with acceptable image noise.

Conclusions: The results based on the 4D scan protocols can be used to improve the accuracy of gross tumor volume definition in the lung and abdomen.