Purpose: To evaluate the feasibility of a real-time position estimation algorithm using positron emission tomography (PET) and investigate the geometric accuracy of the proposed algorithm.

Method and Materials: The algorithm was implemented using listmode PET and RPM respiratory tracking data acquired from a phantom programmed to move with measured respiratory traces from five human subjects, for which the ground truth target position was known as a function of time. The phantom consisted of fluid filled cylinder containing six hollow spheres of diameters 10, 13, 17, 22, 28, and 37 mm with a target:background ratio of 8:1. Motion of the phantom was synchronized to respiratory motion during data acquisition. Images were continuously reconstructed with increasing acquisition time (steps of 100 msec) based on displacement gating. We evaluated the geometric accuracy of the algorithm by quantifying errors between the center of mass (COM) trajectory determined by the proposed algorithm and actual motion of the target.

Results: The COM trajectory by the proposed algorithm converged to actual motion within the accuracy of 1.08±1.26 mm (average error), although shape distortion persisted due to the low number of coincidence events. The largest errors occurred 1) at the beginning of scans due to small number of coincidence events and 2) outside of gate boundaries. Better results were obtained for larger targets due to the partial volume effect. The average error over all subjects for the 10 and 37 mm targets was 1.68±1.88 mm and 0.78±0.74 mm, respectively.

Conclusion: We investigated the potential to use PET for real-time tumor tracking by estimating tumor positions. Even if a fast reconstruction algorithm is required, PET has the potential to enable real-time tumor tracking for IGRT.

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