

LOWER BOUNDS ON THE BIAS OF TUMOR ACTIVITY ESTIMATES FROM RESPIRATORY MOTION IN COMBINED PET AND CT. S. C. Moore, S. P. Müller and M. F. Kijewski, Brigham & Women's Hospital and Harvard Medical School, Boston MA, and Universitätsklinik, Essen, Germany

An advantage of combining oncologic images from CT (or MRI) with those from PET (or SPECT) is that tumor location and size information from the morphologic modality may be useful for improving estimates of tumor activity uptake from the emission data. Patients are imaged while breathing normally in PET, but usually maintain an end-inspiratory breath hold for the CT scanning. Differences in tumor motion or position during the two acquisitions will bias activity estimates obtained by combining information from both modalities. **Objectives:** To evaluate these effects, we simulated spherical tumors imaged under conditions of normal respiratory motion (1.2s inspiration, 2s expiration, 1.8s quiescent end-expiration) in the axial or transaxial directions on PET, while assuming either breath-hold imaging or end-expiratory gating on CT. **Methods:** Activity estimates were obtained by cross-correlating the tumor template from the CT projections with the motion-blurred PET projections, assuming perfect knowledge of the PET system's spatial resolution. This approach yields the best possible performance because (1) uptake estimates are independent of the reconstruction, (2) background uptake is assumed to be perfectly correctable, and (3) effects of respiratory motion on the PET attenuation-correction were ignored. **Results:** For transaxial tumor motion with a maximum amplitude of 1 cm during PET, an end-inspiratory breathhold on CT led to an underestimation of tumor activity ranging from 37% for a 0.75-cm-diameter tumor to 10% for a 3-cm tumor. For axial motion of the same amplitude, the underestimation ranged from 60% (0.75-cm tumor) to 19% (3-cm tumor). Assuming that the CT data were acquired, instead, only during an end-expiratory gating window (40% of the respiratory cycle), the bias of the 0.75-cm tumor was improved to -19% (transaxial motion) and -32% (axial motion), or -16% and -28%, respectively, after a registration procedure. Identical end-expiratory gating of the PET scanner should provide unbiased activity estimates, but with a 58% worse precision. **Conclusions:** Respiratory motion can be a major source of error in tumor activity estimates from PET and CT data.