Purpose: Imaging of lung cancer with 4D PET has recently received much attention in oncology diagnosis and staging. Independently studies have also shown the feasibility of dosimetric evaluation of delivery efficacy of lung stereotactic body radiotherapy (SBRT) using an EPID in cine mode. We propose a novel method to evaluate treatment delivery by quantifying dose deposited in the residual tumor using 4D PET and in-treatment imaging.

Methods: A two-step dosimetric evaluation of treatment delivery for lung SBRT is proposed. First, delivered dose is calculated by motion-corrected fluence. Megavoltage images are recorded throughout treatment delivery, and tumor positions are tracked using a multi-template tracking algorithm for all fields and fractions. The delivered fluence is obtained by convolving the tracked tumor positions with the planned fluence. Utilizing the convolved fluence, the 3D delivered dose is obtained. Second, treatment delivery is evaluated utilizing a post-therapy 4D PET scan. High FDG uptake regions are segmented as sites of residual disease at each phase of 4D PET images. Residual structures are then fused with the planning CT using regional image registration. Relying on the pre-computed delivered dose, dose volume histograms (DVHs) are obtained for the residual structures.

Results: We validated the method using clinical data acquired from lung SBRT treatments. The planned and delivered DVHs were compared and verified on the target volume. The delivered dose to the residual tumor was calculated for each phase of 4D PET. For a patient with large tumor motion (1 cm), 10% deviation from prescription dose is observed at inhale phase of breathing.

Conclusions: Dose delivered to residual disease provides critical evidence for evaluation of the efficacy of treatment delivery. 4D PET has a potential impact on dosimetric evaluation for lung cancer treatment.