Purpose: Four-dimensional cone-beam CT (4D-CBCT) is a novel imaging technique used to guide treatment setup for patients with pulmonary lesions by providing additional information about tumor motion at the time of treatment. This study aimed to evaluate the efficacy of the 4D-CBCT capability in ensuring accurate patient setup during SBRT.

Methods: Twelve patients with pulmonary lesions were imaged pre-treatment with Elekta XVI4.5 using the Symmetry protocol resulting in a respiratory correlated 4D-CBCT. Reconstruction produced 10 phased-based and one average 3DCT image set. Patient shifts were derived from contour-based(mask) registration driven by the weighted average of shifts from each phased CT(4D shifts). Physicians reviewed registration and manually adjusted shifts based on visual registration.

We exported the average 3DCT to MIM Vista Software 5.1.1 in reference volume coordinates and manually fused to the reference CT. All manual fusions were contour-based registrations performed by a single observer. No rotations were permitted in manual fusion to mimic clinical procedure. Translational 3D shifts from manual fusion were compared to 4D(automatic registration) shifts and final physician-corrected shifts.

Results: Mean differences between 4D and 3D shifts in lateral, longitudinal, and vertical directions were 1.07mm, 5.92mm, and 1.43mm, respectively. Mean differences between physician-corrected and 3D shifts were 1.41mm, 4.83mm, and 1.61mm. Differences between 4D shifts and 3D shifts increased with increasing tumor motion. One patient had consistently large longitudinal differences between 4D and 3D shifts (mean=3.0cm). Further review revealed poor 4D registration(via mask and clipbox) on the XVI system which was corrected by physician adjustment prior to treatment.

Conclusions: 4D-CBCT is a valuable imaging tool in patient setup. Physician review of contour-based registration is imperative in preventing a geometrical miss. Caution must be employed in tumors that exhibit a large degree of motion. Further research is necessary in determining functional limits of the 4D-CBCT system.