Purpose: Maximum intensity projection (MIP) reconstructed 4D CT reflects the range of target motion and thus is generally used for internal target volume (ITV) definition in lung stereotactic body radiotherapy treatment planning. During treatment delivery, CBCT is used for image guidance by aligning the target in the CBCT within the MIP-based ITV. This work investigates whether these two image modalities are equivalent in determining the range of the target motion.

Methods: A ball-shaped polystyrene phantom with built-in cube and sphere was attached to a motor-driven platform, which simulates a sinusoidal movement with changeable motion amplitude and frequency. Target motion was simulated both one- and two-dimensionally by adjusting the platform alignment angle with the patient superior-inferior (S-I) direction. The Varian on-board Exact Arms kV CBCT system and the GE LightSpeed 4-slice CT integrated with Respiratory Position Management 4DCT scanner were used to scan the phantom that moved with four motion periods and varying peak-to-peak amplitudes. MIP images were produced. The maximum dimensions of the moving objects visualized in the two sets of images were measured on axial, coronal, and sagittal views and compared, respectively.

Results: When the motion is along the S-I direction, the measured dimensions along the right-left and AP directions agree with the objects’ dimensions with small uncertainties. The measured dimension along the S-I direction in the MIP and the CBCT differ by a maximum of 10.2%, with a larger uncertainty associated with CBCT-based measurements. We also found that the measured dimensions and the centroid positions of each object do not change with motion period, but with motion amplitude.

Conclusions: The measured maximum dimensions of the objects, which are not affected by the motion frequency but by motion amplitude, are comparable between the two image modalities. Therefore, in general, CBCT and MIP images are equivalent in determining target motion.