Purpose: To evaluate the dosimetric accuracy of a novel CBCT estimation method using prior information for use in adaptive radiotherapy (ART)-based treatment of lung cancer patients.

Methods: Patient planning CT or previous day's CBCT images are used as the prior images. The new CBCT images are considered as a deformation of the prior images. The deformation field is solved by meeting the data fidelity constraint and minimizing the deformation energy of the field. The new CBCT images are then obtained by deforming the prior images according to the deformation field. Data for ten lung cancer patients were tested for estimation using 57 projections acquired over 60° and 360° scan angles. The new CBCT reconstructed from fully sampled projections were used as the ground truth. Geometric accuracy of the estimation was evaluated using tumor volume percentage error. Dosimetric accuracy was evaluated by comparing the PTV dose distribution in each set of images.

Results: The tumor volume percentage error was 13.3% and 4.3% in CBCT estimated using 57 projections over 60° and 360° scan angles, respectively. PTV min., mean and max. doses in estimated CBCT agree with those in true CBCT within 2% and 1% for 60° and 360° scan angles, respectively. The percentage volume of PTV covered by prescription dose in estimated CBCT agrees with that in true CBCT within 4% and 1% for 60° and 360° scan angles, respectively. The isodose lines in the estimated CBCT images also match well with those in the true CBCT images.

Conclusions: The proposed method is able to provide accurate guidance for plan adaptation in ART treatment of lung cancer patients using 57 projections acquired over 360° scan angle. This implies a 12-fold reduction in imaging dose relative to conventional CBCT for similar image quality for target delineation and dose calculation in ART.