Purpose: Megavoltage cone-beam CT (MVCBCT) images used for patient positioning can also detect complex changes in neck flexion and head rotation. Deformable image registration (DIR) algorithms could automate detection of positional variability and facilitate adaptive therapy strategies. This study investigates the ability of DIR to track changes in neck flexion, jaw position, and head tilt in MVCBCT images of head-and-neck radiotherapy patients.

Methods: Landmark points at the base of skull, along the cervical vertebral column and on the mandible were identified and annotated on planning kVCT and MVCBCT images of patients. Baseline MVCBCT images were first fused to the kVCT via rigid registration, and distances between corresponding landmark points were computed. The same MVCBCT images were then fused via DIR, and the vector displacement between landmark points and deformed points was calculated. The change in the distance using DIR versus rigid registration was used to quantify how well the deformation algorithm tracked the shift of landmark positions. The same tests were also performed by registering and deforming the baseline MVCBCT to another MVCBCT taken at a different time.

Results: Data for 11 reference points and images from five patients were analyzed. Changes in landmark distance of greater than 1 mm were considered. Deforming the MVCBCT to the kVCT, one patient showed an average decrease in landmark distance of 3 mm after DIR. However, the landmark distance increased by an average of 2 mm for another patient. When deforming the baseline MVCBCT to another MVCBCT, all five patients showed an improvement in landmark matching. The average decrease in landmark distance varied from 0.4 mm to 3.4 mm.

Conclusions: Deforming MVCBCT to kVCT images of the head-and-neck region did not consistently improve landmark matching. However, DIR consistently improved landmark matching when applied to two MVCBCT images acquired at different times.