Purpose: To improve image quality of 4D CBCT FDK reconstructions by rebinning using 3D tumor trajectories acquired with orthogonal dual source kV imaging.

Methods: The Shepp-Logan in-silico phantom was used to generate artificial single and dual source projection images during 4D CBCT acquisition. The Shepp-Logan phantom was modified by adding a 3 cm tissue equivalent sphere inside an air cavity. The sphere was moved inside the phantom by applying six minutes of tumor motion retrieved from a Cyberknife treatment. Images were generated with frame rates of 12 fps and an acquisition speed of 1 degree per second.
Through detection of a marker inserted in the moving sphere, the 3D tumor motion trajectory was extracted from the projection data. The projection images were binned either based on the 1D marker motion in the cranial-caudal direction for 8 phases or based on the 3D marker position using orthogonal images. The 1D rebinning technique was used for both the single and dual source acquisition. The dual source marker projections formed a 3D point cloud representing the tumor track. The track based rebinning used the 175 most proximal marker locations corresponding to 350 projections with minimal intra-bin residual motion.

Results: Differences between single and dual source CBCT images were small, although dual source CBCT used less breathing cycles. The contrast-to-noise ratio for the track based reconstruction was significantly higher compared to 1D rebinned reconstructions. An intra-bin motion of 2.0 ± 1.4 mm was found for 1D rebinned dual source images and 1.2 ± 0.4 mm for track based rebinning. Maximum intra-bin motion after track rebinning was found to be 2.2 ± 0.8 mm.

Conclusions: Using track-based rebinning for 4D CBCT in dual source acquisition, intra-bin residual motion is reduced and image quality was improved for reconstructions with projection images from irregular breathing.