Purpose: To develop a 4D cone beam CT (4DCBCT) reconstruction algorithm that produces a time series of images with high spatial and temporal resolution, minimal artifact, and no time averaging of data as compared to standard 4DCBCT reconstruction techniques.
Methods: Our algorithm works to constrain a motion model by using it to deform a static prior CT image at multiple time steps. It then adjusts the motion model parameters until digitally reconstructed radiographs (DRRs) taken through the deformed prior optimally match the projections of the raw 4DCBCT data-set. Once the motion model parameters have been optimized the motion model can be used to animate the static CT, in essence producing a 3D video that serves as the reconstructed 4DCBCT. Our motion model uses principal components analysis (PCA) of a DVF training set to generate eigenvectors characterizing de-correlated modes of anatomic motion. It produces new DVFs by computing weighted sums of the eigenvectors. Each eigenvector weight, or principal coefficient, varies in time uniquely according to a parameterized version of the patient breathing trace.
Results: Our current focus is on proof of concept testing using numerically generated data. We plan to test the algorithm on simulated data with different degrees of motion complexity. In addition, we will test the effect on eigenvector quality of different DVF training set acquisition methods. Early results indicate that when supplied with an ideal DVF training set the model can reproduce simple motion to a high degree of accuracy.
Conclusions: Our current task is to test our algorithm's reconstruction quality with numerically simulated data of varying complexity. Beyond that we plan to test on phantom and patient data. If our reconstruction algorithm is successful it will produce 4DCBCTs with high spatial and temporal resolution, low artifact, and no time averaging.

Funding Support, Disclosures, and Conflict of Interest:

This work supported by NIH P01 CA116602.