Purpose: To quantify the dependence of helical-based 4D-CT image quality on pitch and to identify plausible correction techniques without increasing mAs.

Methods: A commercial respiratory motion quality assurance phantom was imaged using a clinical, helical-based 4D-CT protocol on a Philips Big Bore 16-slice CT scanner (Philips Medical Systems, Cleveland, USA). Scans with identical parameters were repeated under various conditions including breathing period, motion amplitude, pitch, and mAs. Scans were retrospectively reconstructed into ten equal phases (4D phases) of one breathing period. Reconstructed phases were used to generate an average image of all ten phases (avg-IP) used as a non-gated planning CT and a subset average of the 30-60% phases (subset-IP) used as the respiratory-gated planning CT. Raw data from each scan was also used to reconstruct a low-pitch helical CT scan call the Untagged Average CT (Untagged-IP). Analysis of axial slices involved the placement of identical regions of interest (ROI's) on predetermined slice locations for moving and static components of the phantom. The average standard deviation (noise) was computed over several ROI's for each component.

Results: The reconstructed individual 4D-CT phases, avg-IP, and subset-IP demonstrated a strong increase in noise as pitch decreased. Both the avg-IP and subset-IP improved over any single phase of the 4D set for all breath rates. The noise in the untagged-IP was independent of pitch for all breath rates and was consistently lower than the avg-IP or any phase of the 4D-CT dataset.

Conclusions: Decreasing pitch for a helical-based 4D-CT scan degrades image quality. Two specific reconstruction techniques that can help compensate for image degradation are, the untagged-IP for non-gated cases and the subset-IP for gated cases. Both techniques can overcome the pitfalls of using a single respiratory phase without increasing mAs.