Purpose: The choice of sorting method used to genereate 4DCT image sets can affect image quality and target volume delineation. This study evaluated, in phantom and patient, the impact of a novel hybrid amplitude-based (hAB) 4DCT sorting algorithm on the delineation of internal target volume (ITV), and results were compared with conventional phase-based (PB) sorting.

Methods: Eight phantom experiments were performed using respiratory motion platform programmed with simple ((1-cos2), 5 second cycle) and complex (from RPM patient data) breathing curves with S-I lung-tumor excursion. 4DCT images were acquired, and corresponding datasets were sorted (10 phases) using both phase and hAB sorting algorithms. A retrospective study of nine early-stage lung cancer patients were also reconstructed using both sorting algorithms, and maximum intensity projections (MIPs) were generated from each 4DCT dataset. ITVs for both phantom and patient data were auto-contoured on each MIP. ITV volumes and centroids were compared between sorting algorithms.

Results: For all phantom and patient studies, hAB produced smaller or equivalent ITVs than the PB approach. Average percent difference in delineated ITV volume was 5.2% (range: 0.0 – 13.5%) and 3.0% (range: 0.2 – 7.9%) for patient and phantom studies, respectively. For the patient study, the largest percent differences occurred when lateral or anterior-posterior tumor motion was present. Average variation in centroid coordinates was < 1mm for all phantom and patient cases studied. The largest variation in ITV extent was expressed in the sup-inf direction in the phantom study. Noticeable sorting artifact was observed for two phantom cases for both the hAB and PB sorted data.

Conclusions: This study demonstrates clinical application of a novel hAB 4DCT sorting algorithm. We have quantified the variation in ITV delineation stratified by sorting technique, and revealed situations which may increase the potential for the underestimation of full tumor volume extent encompassing motion.

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Conflict of Interest: Henry Ford Health Systems holds a research agreement with Philips Medical Systems