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PRESENTATION TITLE

Lung tumor delineation and motion assessment using T2w respiratory-correlated 4DMRI

AUTHOR(S)

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ABSTRACT

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Purpose: To evaluate the potential clinical benefits of using T2w respiratory-correlated (RC) four-dimensional magnetic resonance imaging (4DMRI) for tumor delineation and motion assessment in comparison to 4D computed tomography (4DCT) for respiratory-gated radiotherapy of lung cancer.

Materials & Methods: A prospective T2w RC-4DMRI technique was used to scan 7 non-small cell lung cancer patients with 8 lesions (stage I to III) under an IRB-approved protocol. The 8 tumors were sorted into a large motion group: gross tumor volumes (GTVs) (2, 5, 7, 125 cc) moved 10-25 mm and a small motion group GTVs (19, 47, 82, 127 cc) moved < 5 mm. For each patient, a free breathing (FB) T2w 4DMRI and a breath hold (BH) T1w 3DMRI were acquired in treatment position in addition to a planning FB CT and 4DCT. All CT and MR images were acquired the same day using the same immobilization mold. For 4DMRI acquisition, an internal navigator echo placed on the right diaphragm dome for respiratory binning, while for 4DCT an external respiratory surrogate (a bellows or real-time positioning management, RPM) was used. Three radiation oncologists independently delineated the GTVs on all respiratory phases of 4DCT, T2w 4DMRI, and on a T1w BH 3DMRI after fusing them to the planning CT on the bony structure using a programmed workflow. The mean GTV volumes on 4DCT and T2w 4DMRI were compared with that on the T1w BH MRI. The GTV

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variability was compared between 4DCT and 4DMRI. The GTV motion trajectories were measured using the center of mass. The GTV motion envelopes were compared between 4DCT and 4DMRI and quantified with the Dice index and Mean Distance to Agreement (MDA).

Results: The mean GTV volumes were found to follow the trend: 4DCT (normalized to 1.0) > T2w 4DMRI (0.85±0.10) > T1w BH 3DMRI (0.62±0.20), primarily owing to reduced image binning and blurring artifacts in the navigator-binned 4DMRI and BH MRI images. The size difference may also be caused by imaging modality difference due to a possible GTV-wrapping edema layer that can be visualized by CT and T2w MRI, but not as clearly on T1w MRI. For two lower lobe tumors (2 and 7 cc) with large motion, the GTV volume variability within the breathing cycle was reduced substantially from 65% on 4DCT to 28% on 4DMRI due to fewer binning artifacts on the 4DMRI. The motion range variations and corresponding GTV envelope for the large motion group varied from 50% to 300% and 80% to 132%, respectively, between 4DMRI and 4DCT scans due to breathing irregularities. For two upper lobe GTV motion envelopes (48 and 148cc) with small, but similar motions ($\Delta < 2\text{mm}$), a Dice index of 0.80±0.02 and MDA of 2.4±0.2mm were observed between 4DMRI and 4DCT.

Conclusions: T2w RC-4DMRI contains fewer artifacts and provides more consistent GTV delineation with smaller variability in comparison with 4DCT. Further investigation is needed to confirm the smaller lung GTV from RC-4DMRI and its cause prior to clinical applications.