Purpose:

We hypothesize that PTV margin dose is an important factor for local tumor control. We evaluated dose distributions for patients originally treated with pencil-beam (PB)-based plans and retrospectively calculated with Monte Carlo (MC) method, with emphasis on the spatial region between the ITV and PTV (PTV-margin), where the largest dose differences were expected.

Methods:

Forty-six stage I-II lung cancer patients with 51 lesions treated with SABR were retrospectively analyzed (23 central and 28 peripheral tumors). All patients received 4DCT imaging, and an ITV was generated from the maximum intensity projection and subsequent review of four 4DCT phases. An isotropic 3mm ITV-to-PTV margin was used. The iPlan TPS was used to generate the original treatment plans using PB-based heterogeneity correction. MC doses were recalculated using the same MUs as in the PB plan. Dose distributions for the ITV, PTV-margin, and PTV were analyzed using generalized equivalent uniform dose (gEUD) with $a = -20$. Student's paired t-test elucidated differences between PB and MC-based gEUD and the two different tumor locations.

Results:

Mean ITV and PTV volumes were 24.2 cc (range: 2.2 to 99.3 cc) and 50.4 cc (range: 6.4 to 229.7 cc), respectively. The mean gEUDs of ITV, PTV-margin and PTV, normalized to PB-based 100% isodose were 1.02+/-.04, 1.01+/-.04 and 1.01+/-.04 for PB-based plans, compared to 0.94+/-0.06, 0.88+/-0.08 and 0.90+/-0.08 (all p<0.05) for MC-based plans. The maximum overestimations with the PB algorithm in the PTV-margin average dose were 10.4% and 19.6% (p < 0.05) for peripheral tumor cases and central tumor cases, respectively.

Conclusions:

PB-based dose distributions showed the highest dose overestimation (relative to MC) in the PTV-margin spatial region. Analysis of spatial dose differences is an important precursor toward assessment of patterns-of-local failure, to be investigated in future work to explore possible association between dose and regions of failure.

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