Purpose: Current commercially available planning systems which utilize MC algorithm-based final dose calculation in IMRT planning employ pencil-beam algorithms in the optimization process. Consequently, dose coverage for SBRT lung plans can be quite non-uniform, featuring cold-spots in the tumor periphery for "island" lesions within the lung, and, for other locations, hot-spots within nearby normal organs (example: rib-cage). This study evaluated practical approaches to reducing dose non-uniformity within the target and surrounding normal organs in MC-based IMRT planning.

Methods: We evaluated two different IMRT-based approaches. (A) Iterative planning where the MC calculation (with pencil-beam-based optimization) is initially performed. The resultant cold spot is then contoured and used as a simulatneous boost volume. The MC-based dose is re-computed and the prescription dose re-normalized to 95% of the PTV. Ten SBRT lung cases with tumors seated near the lung-wall/rib-cage interface were planned. (B) Planning in which coplanar and non-coplanar beam angles with limited path through lung tissue were selected. Both techniques were evaluated against the conventional coplanar-beam approach: a single MC calculation and prescription dose normalization to 95% of the PTV.

Results: Technique A: conformity index (CI) and PTV dose uniformity (U_PTV) improved in seven of ten plans. Average improvement (+/- standard error) was 10.8%+/-2.7%, and 22.4%+/-5.4%, respectively. Non-significantly improved plans had PTVs near the skin, trachea and/or very small lung involvement. The maximum dose to 1cc volume (D1cc) of surrounding OARs decreased in nine of ten plans (average 10.6%+/-4.3%), with only the skin-adjacent PTV plan showing no improvement. Technique B: we demonstrated an improvement of 11.2% and 2.6% in CI and U_PTV, respectively, and a D1cc reduction of 7.8% to surrounding OARs.

Conclusions: The proposed practical approaches improve dose conformity in MC-based IMRT planning of lung tumors treated with SBRT, improving target dose coverage and potentially reducing toxicities to surrounding normal organs.

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