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Fully Automating Lung Cancer LATTICE Radiation Therapy (LRT) Using Multi-Focal Dynamic Conformal Arc (DCA) Delivery: A Feasibility Study

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Abstract

Objectives:

Spatially fractionated radiation therapy (SFRT) shows improved therapeutic effect of radiotherapy (RT) through bystander effects while reducing normal tissue toxicity for late stage cancer patients. As one form of SFRT, Lattice Radiation Therapy (LRT) delivers highly spatially modulated radiation dose. LRT treatment planning for locally advanced lung cancer patients consists of vertices placement and subsequent treatment planning to customize highly conformal dose to the vertices. This study aims to fully automate this two-step process for patient receiving LRT on Linear Accelerator (Linac).

Methods:

The proposed workflow starts with the planning target volume (PTV) contoured by the attending. Then vertices are packed optimally within the PTV. A hexagonally close-packed (HCP) algorithm was developed to pack maximum number of vertices within the planning target volume (PTV). The vertices matrix was calculated to obtain geometrically optimal packing through the acceptance and rejection of vertices. Once the vertices are determined, a multi-focal dynamic conformal arc (DCA) was created. This process was automated via solving state-transition equation which respects the physical limitation of gantry rotation and leaf motion. All calculation was performed in Matlab and the final plan with leaf sequence was imported back to Eclipse Treatment Planning System (v16.0) for dose calculation. One late-stage lung cancer patient was simulated with vertices settings of 6 and 9 for a single fraction plan of 20Gy. Average max target dose, valley dose and peak-to-valley ratio (PVR) were reported.

Results:

The simulated patient presented a PTV of 1535 cc. For 6-vertex packing, average maximum target dose was 25.2 Gy while the dose valley was 5Gy. The PVR was 5:1. For 9-vertex packing, average maximum target dose was 21.3Gy with dose valley of 5Gy. The PVR was 4.3:1.

Conclusion(s):

In this study, we demonstrated that the proposed fully automated workflow for lung LRT is feasible and the dosimetric endpoint is decent. More validation is needed in the next phase of this study to demonstrate robustness and clinical acceptability.