Purpose:
We propose a practical four-dimensional (4D) planning scheme of intensity-modulated arc therapy (IMAT) for tumor tracking using dynamic multileaf collimators (MLC).
Methods:
We contour the target and critical structures on each image set of 4DCT associated with each breathing phase. Transformation vectors of the target from a reference phase to other phases are derived. A 3D-IMAT plan is first optimized on the reference phase without motion-induced margin. Assuming delivery starts at a predetermined breathing phase and the patient breathes the same way as during 4DCT imaging, we know the phases at which each planned segment will be delivered. Then, we transform the optimized segments from the reference phase to the phases of their delivery based on projections of transformation vectors of the target in the beam's eye-view. The connectivity of the transformed segments between adjacent beam angles is enforced. The dose for each phase is calculated using segments delivered at that phase, and transformed to the reference phase to obtain cumulative dose. The resulting 4D plan is compared with the 3D plan without considering respiratory motion and with motion-induced margins. Effects of enforcing connectivity on the plan quality are also evaluated.
Results:
Compared to the PTV dose of 3D plan without tumor tracking, the 4D PTV dose is more conformal and uniform, and it approaches the ideal situation of the patient being static. The 4D plan also showed better critical organ sparing than the 3D plan with motion-induced margins. Adding MLC motion required for tracking to the planned motion rarely causes physical constraints to be exceeded, and enforcing connectivity thus has little effect on plan quality.
Conclusions:
The proposed scheme of 4D-IMAT planning for tumor tracking is a feasible and practical approach under the current clinical planning environment. Dosimetric benefits of 4D planning have been clearly demonstrated.

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