

AbstractID: 10512 Title: Dose escalation by target-tracking treatments planned by 4D direct aperture optimization: A proof of principle.

Purpose:

To evaluate a novel 4D direct aperture optimization system capable of planning a 4D-tracking delivery while ensuring compliance with the delivery constraints. The planning system was tested by deriving the change in tumor-control probability (TCP) by dose escalation with a fixed mean lung dose (MLD) in a digital phantom dataset.

Method and Materials:

The treatment fields were divided into phases matched to phases of a 4D-patient model. Compliance with delivery constraints was ensured by restricting equipment configurations within phases and changes between phases to deliverable settings. The optimization cost was evaluated by comparing the dose distribution summed over the breathing cycle with a prescription. The potential clinical benefit of the system was evaluated with a dose escalation study on a 4D digital phantom. The acceptable MLD was derived from a reference static plan with 64Gy prescribed to the target with motion-encompassing margins. The TCP was optimized for the fixed MLD, where the TCP was evaluated at 12 months using the method of Martel et al. (1999).

Results:

With a fixed MLD (13Gy) the 4D-tracking treatment achieved a mean target dose of 79.6Gy as compared to 63.8Gy for a static plan and 73.9Gy for a plan optimized on the 4D patient but with no motion of the delivery equipment (denoted 4D-static plan). The resultant TCP increased from 49.6% for the reference plan to 75.4% for the 4D-tracking plan compared to 45.6% for the static plan and 66.5% for the 4D-static plan.

Conclusion:

A treatment-planning system capable of optimizing target-tracking treatments complying with delivery constraints has been developed and tested. The tracking deliveries produced have been evaluated by the allowed dose escalation for a simple example case, where a substantial improvement in TCP was observed. This finding shows that the technique is very promising and worthy of further study.