Purpose: To develop a novel tracking technique for intensity modulated radiation therapy (IMRT) based on dynamic virtual patient modeling.

Method and Materials: Predictive tracking uses a dynamic virtual patient model to account for the three-dimensional deformable motion of the target during realistic IMRT deliveries. The virtual patient model was developed based on the 4DCT images and the structure contours delineated on different respiratory phases. With a real-time breathing curve, the virtual patient model could be updated to a real-time model which would then be used to predict the motion of the target, to modify the IMRT leaf sequence on-line to account for the target motion, and to calculate the delivery dose of the IMRT plan with consideration of the interplay effect. A lung case was chosen to demonstrate predictive tracking. The quality of the predictive tracking plan was compared with two commonly used 4D IMRT treatment planning techniques: maximum intensity projection (MIP) and planning on individual phases (IP).

Results: For a realistic breathing motion, predictive tracking offered better plan quality than MIP and IP. PTV V97 was 90.4% for a MIP plan, 88.6% for an IP plan and 94.1% for a predictive tracking plan. Lung V20 was 20.1% for the MIP plan, 17.8% for the IP plan and 17.5% for the predictive tracking plan.

Conclusion: Predictive tracking based on dynamic virtual patient modeling is a novel 4D planning/delivery technique which is capable of managing the real time 3D deformable motion of target without increasing the workload of treatment planning or time of delivery. For a realistic breathing motion with consideration of the interplay effect in beam delivery, predictive tracking gave better plan quality than IP and MIP.

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