AbstractID: 9237 Title: An N-state 4D convolution dose calculation algorithm in proton and photon therapy

Purpose: 4D dose calculation can accurately predict the doses received by a deforming anatomy in the presence of the intra-fraction respiratory motion. However, 4D dose calculation is time consuming since it requires a separate dose calculation for each phase of the 4D datasets. The purpose of this work is to develop and validate a method which can correctly predict the 4D dose distribution using fewer 4D datasets.

Method: An n-state 4D convolution dose calculation method was implemented to perform the 4D dose calculation in intensity modulated photon therapy (IMXT), passive scattered proton therapy (PSPT) and intensity modulated proton therapy (IMPT). n-state 4D convolution dose calculation was to calculate the doses at n selected phases of 4D CT and convolve the calculated doses with the deformation vectors for each phase obtained through a deformable image registration algorithm. One-state 4D convolution dose calculation was compared with full 4D dose calculation for an IMRT plan. One and two-state 4D convolved dose distributions was compared with full 4D dose distribution for a PSPT and an IMPT plan.

Results: The dose volume histogram (DVH) was almost identical between one-state 4D convolved dose and full 4D dose for the IMRT plan. One-state 4D convolution dose calculation did not predict the target coverage well for the PSPT and IMPT plans. The DVHs was predicted reasonably well by two-state 4D convolution dose calculation for PSPT plan but was not good enough for the IMPT plans.

Conclusion: For proton and photon plans, the apparent dose could be different from the 4D dose. One-state 4D convolved dose agrees well with full 4D dose, indicating the 4D dose calculation for the photon therapy could be obtained much faster. At least two-state 4D convolution dose calculation was required for the proton therapy.