AbstractID: 9263 Title: Implementation of random patient setup uncertainties into Pinnacle-based IMRT optimization

Purpose:
To incorporate patient positioning uncertainties directly into IMRT plan optimization through probabilistic treatment planning (PTP). Margin-based planning results in significant normal tissue volumes being exposed to a treatment dose. PTP eliminates explicit margins and operates directly on the expectation value of the integral treatment dose to determine the optimal dose to the patient in the presence of setup uncertainties.

Method and Materials:
Three prostate patients and one phantom plan are optimized using both margin-based and PTP methods. Patient plans are designed to adhere to the RTOG-0126 criteria. Only random errors are considered. For the margin-based plan, the PTV is created by expanding the CTV by 2.1 mm to accommodate the 3 mm random setup uncertainty simulated. PTP directly utilizes the CTV during plan optimization. Random setup uncertainties are introduced into the Pinnacle IMRT TPS by convolving each beam's incident fluence with a σ=3 mm Gaussian. PTP optimization uses the convolved fluence dose. PTPs are compared to PTV-based margin plans with equal CTV coverage in the presence of setup errors. Normal structure doses are used to quantify PTP and margin-based differences.

Results:
Both margin-based and PTP plans meet 33 of 42 optimization criteria. For critical structures which did not meet the criteria, PTP shows decreased volume receiving the maximum specified dose. PTP reduces normal tissue volumes receiving the maximum dose on average by 57%, while the CTV volume loss is 2.5%. PTP reduces the CTV mean dose by 0.22%. PTP also results in lower doses to structures that meet the optimization criteria.

Conclusion:
PTP accounting for random patient positioning uncertainties was incorporated into Pinnacle. For equal target coverage, PTP results in equal or lower doses to normal structures than margin-based plans. (Work supported by NIH P01CA116602 and T32CA113277)

Conflict of Interest:
An author is employed by Philips Medical Systems.