AbstractID: 4984 Title: Application of dose uncertainty model for plan evaluation

Purpose: To provide the applications of dose uncertainty model for intensity-modulated radiation therapy (IMRT) plan evaluation.

Method and Materials: The dose uncertainty in radiation therapy is proportional to the product of dose gradient and spatial displacement (space-oriented uncertainty) and inversely proportional to dose level (non-space-oriented uncertainty). Since both dose uncertainties are assumed independent, the total dose uncertainty is their square root of quadratic sum ($\sigma(\vec{r}) = \sqrt{\sigma_s(\vec{r})^2 + \sigma_{ns}(r)^2}$). If the dose distribution consists of multiple fields, the total uncertainty is the square root of quadratic sum of dose uncertainties of all beam segments. To apply the uncertainty model to IMRT plan evaluation, three patients were selected and three different step-and-shoot IMRT plans for each patient were made with 95% of planning target volume (PTV) covered by prescribed dose (180 cGy) using Philips Pinnacle[3]. Three-dimensional (3-D) dose uncertainty distributions were calculated with 1% relative dose uncertainty at the prescribed dose level and 1 mm spatial displacement along each Cartesian axis as one standard deviations assuming Gaussian distribution. The uncertainty distributions added to and subtracted from the calculated dose distribution were employed to make isodose lines with 95% confidence interval (1.96σ). The plans with the isodose lines of each patient were compared to choose more preferable plan. In addition, the uncertainty-volume-histogram (UVH) was developed as an additional tool for plan evaluation.

Results: By observing possible overdose and underdose regions within PTV with 95% confidence level, better plan evaluation was accomplished. Moreover, the plans that might bring less possible damage to organs at risk could be selected by considering both the dose bounds and UVHs of each organ.

Conclusion: The 95% isodose bound and UVH are new useful tools for better IMRT plan evaluation. The uncertainty model can bring a new paradigm of plan evaluation by avoiding the choice of a plan of high risk.