AbstractID: 11288 Title: Sensitivity of Dosimetric Margin Distribution and Coverage Estimates to Sampling Parameters

Purpose: The dosimetric margin distribution (DMD) is a planning tool for evaluating target and normal tissue dose coverage probabilities in the presence of geometric uncertainties. This work evaluates sensitivity of coverage estimates derived from the DMD to the angular increment ω at which the DMD is sampled, and the distance search increment δ.

Method and Materials: The study utilized three plans for localized prostate cancer, with prescribed dose of 79.2Gy and 1cm clinical target volume to planning target volume (CTV-to-PTV) margins, planned according to the high dose arm of RTOG0126. Dose was first recalculated with beam fluences convolved with a normal probability density function to simulate the effect of random uncertainties. Dosimetric margins were then calculated between the CTV and the 79.2Gy isodose surface at elevations ϕ from -90° to +90°, and azimuthal angles θ from -180° to +180°. In each direction (ϕ,θ) the CTV was moved relative to the dose distribution in steps of δ until its minimum dose fell below 79.2Gy. Estimated coverage Q_{est} was calculated from the DMD assuming systematic uncertainties (rigid body translations) were normally distributed with standard deviation Σ along each axis. Minimum and maximum deviations ΔQ_{est} were obtained over a range of Σ values for $\omega = 5°, 10°, 20°$ relative to $\omega = 2°$, and for $\delta = 0.2, 0.5, 1$ mm relative to $\delta = 0.1$ mm.

Results: Coverage uncertainty due to finite angular sampling interval ω is approximately 0.5% at $\omega = 10°$ and 1.5% at $\omega = 20°$. Uncertainty due to finite step size δ is negligible for $\delta \le 0.2$ mm, and is approximately 0.6% for $\delta = 1$ mm.

Conclusion: Coverage estimates accurate to $\pm$0.5% will be obtained if the DMD is sampled with $\omega = 10°$ and $\delta = 0.2$ mm. Coverage estimates accurate to this level are desirable for target and normal tissue coverage evaluation in current treatment plans, and to support future treatment planning based on probabilistic coverage criteria. (Supported by NIH P01CA116602).