AbstractID: 13553 Title: Enforcing maximum dwell times in high dose rate brachytherapy highlights the tradeoff between small dwell time gradients and dose coverage

Purpose

Applicator-based dose optimization (forward planning) emphasizes dwell time homogeneity to avoid regions of exceptionally high dose concentration. Anatomy-based dose optimization (inverse planning) relaxes this constraint in order to obtain a dose distribution that is more conformal the anatomy. We developed a version of inverse planning constrained by maximum dwell times. The relationship between dwell time homogeneity and the dose delivered to cancerous and healthy organs is examined.

Methods and Materials

A software method was implemented within the IPSA inverse planning algorithm to allow for (1) imposition of a user-defined global maximum dwell time at any given dwell position and (2) homogeneity of dwell times within any given catheter. In-silico studies were performed on six previously-treated-patient image datasets using the contours and catheter digitization of the clinically-used plan. Two each of tandem-and-ring gynecological, tandem-and-ovoid gynecological, and prostate were examined. The plan used for treatment served as the control and had no restriction on dwell times. New plans were optimized by imposing either a global (Study 1) or catheter-specific maximum dwell times (Study 2) for different time limits. Dosimetric indices were compared with the control plans.

Results

Clinically acceptable plans were achievable with modest restriction of the dwell times, but severe restriction lead to unacceptable plans. Across all studies, restriction of dwell times correlated with an increase of the final objective function value. A higher objective function means less adherence of the optimization to the dosimetric requirements imposed on the optimization by the user.

Conclusion

Imposing restrictions on a global maximum dwell and intra-catheter dwell time homogeneity necessarily results in a worsening of the dosimetric optimization objective function. However, less severe restrictions can allow for some tailoring of the dose distribution to avoid intra-catheter dwell time heterogeneity with only a small decrease in target coverage.

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