Application of Monte Carlo to Intensity Modulated Radiation Therapy

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ABSTRACT

Intensity Modulated Radiation Therapy (IMRT) seeks to deliver highly conformal tumorcidal doses to selected target volumes while conformably avoiding nearby normal tissues and critical structures. In the optimization process, it is assumed that the optimized planned doses can be precisely and accurately delivered to the patient. However, most IMRT planning systems use simplified fast dose calculations during the plan optimization that are historically known to be inaccurate when radiation disequilibrium conditions exist such as near tissue heterogeneities, for small radiation fields, or in dose gradient regions; precisely the conditions often encountered for IMRT. Monte Carlo dose calculation algorithms are not bound by such limitations and can be accurate under all scenarios. Furthermore, by transporting particles through the beam delivery devices (the MLC), Monte Carlo can also accurately determine the fluence incident upon the patient.

The goals of this presentation are to (1) describe intensity-based and leaf-motion based Monte Carlo dose calculation for IMRT and show the impact of this difference on patient plans; (2) describe how Monte Carlo is currently used in our clinic to validate IMRT treatment plans; (3) describe the technical difficulties of using of Monte Carlo for IMRT optimization and (4) discuss potential strategies for overcoming the difficulties and realizing MC IMRT optimization.