AbstractID: 2687 Title: Prescription and Inverse Planning for Biologically Conformal Radiation Therapy

Purpose: It is well known that the spatial biology distribution in tumors and sensitive structures is heterogeneous. Recent progress in biological imaging is making the mapping of this distribution increasingly possible. The purpose of this work is to establish a framework for quantitatively incorporating the spatial biology data into IMRT inverse planning, and to show its advantage in enhancing the TCP while reducing the NTCP.

Methods: Based on a LQ model, we derive a general formula for determining the desired dose to each tumor voxel for a biology distribution characterized by the clonogen density, radiosensitivity, and proliferation rate. The desired dose distribution is used as the prescription for inverse planning. An objective function with the voxel-dependent prescription is constructed with incorporation of the nonuniform dose prescription. The functional unit density distribution in a sensitive structure is also considered phenomenologically when constructing the objective function. Two cases with different known biology distributions are used to illustrate the new formalism. For comparison, treatments with uniform dose prescriptions and simultaneous integrated boost are also planned. The TCP and NTCP are calculated for each type of plans and the superiority of the proposed technique over the conventional dose escalation schemes is demonstrated.

Results: Our calculations reveal that it is technically feasible to produce deliberately nonuniform dose distributions with consideration of biological information. Compared with the conventional dose escalation schemes, the new technique generates biologically conformal IMRT plans that significantly improve the TCP while reducing the NTCPs.

Conclusion: Biologically conformal radiation therapy (BCRT) incorporates patient specific biological information and provides an outstanding opportunity for us to truly individualize radiation treatment. The proposed formalism lays technical foundation for BCRT and allows us to maximally exploit the technical capacity of IMRT to more intelligently escalate the radiation dose.

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