AbstractID: 8980 Title: Inverse Planning with RBE: a New Concept for the Optimization of Proton Therapy

Inverse treatment planning for intensity modulated proton therapy (IMPT) usually employs a constant relative biological effectiveness (RBE) rather than a variable RBE. To investigate the potential clinical relevance of a variable RBE, we present a new concept for fast three-dimensional RBE calculation and optimization of the biological effect. Three-dimensional distributions of the dose-averaged linear energy transfer (LET) are calculated to serve as a measure of the radiation quality. Data from cell survival experiments were used to obtain the RBE in the framework of the linear-quadratic model, assuming α as a linear function of LET and β as constant. These models for LET and RBE as well as a new objective function have been integrated in our inverse planning tool. As the objective function considers the biological effect directly, the product of RBE and dose can be optimized. The new optimization method was successfully applied to several clinical cases. As desired, the optimization process yielded homogeneous distributions of the product of the variable RBE and the dose in the target while sparing organs at risk. Compared to "conventionally" optimized plans the dose volume histograms of the planning target volume for RBE times dose were steeper for the new optimization method, whereas the physical dose distributions became more inhomogeneous. The proposed concept allows simultaneous multi-field optimization of the biological effect in a reasonable time and is therefore well suited to study the impact of a variable RBE in the optimization of IMPT.