Abstract:
To investigate in a simulation study whether using a variable relative biological effectiveness (RBE) in calculation and optimization of intensity-modulated proton therapy (IMPT) instead of using an RBE of 1.1 would result in significant changes in the RBE-weighted dose (RWD) distributions. For 4 patients with head-and-neck tumors, three IMPT plans were prepared respectively. The first plan was physically optimized (IMPT-PO plan), and the RWD was calculated with a constant RBE of 1.1. Then the plan's RWD was recalculated (IMPT-R plan) using a variable RBE model taking into account the linear energy transfer (LET) and tissue-specific radiobiological parameters. The third IMPT plan was optimized using a biological optimization routine (IMPT-BO plan). Comparing the IMPT-PO and IMPT-R plans, we observed that the RWD in radioresistant tissues was more sensitive to the LET than in radiosensitive tissues. The IMPT-R plans were in general more inhomogeneous than the IMPT-PO plans. The differences of RWD distributions for all volumes between IMPT-PO and IMPT-BO plans complied with predefined dose-volume constraints. The average LET was significantly lower in IMPT-BO plans than in IMPT-R plans. In radioresistant normal tissues caution has to be used regarding the LET distribution.
because these are most sensitive to changes in the LET. Biological optimization of IMPT plans based on the organ-specific biological parameters and LET distributions is feasible.