

AbstractID: 10517 Title: Nanodosimetry as a tool for predicting the RBE of therapeutic proton beams

Purpose: One of the uncertainties in proton therapy is the depth dependence of cell survival RBE. Nanodosimetry is an experimental gas-based technique that can also be simulated with Monte Carlo radiation transportation codes. Agreement between experimental and simulated nanodosimetric data has previously been presented. Here we explore the use of simulated nanodosimetric distributions for prediction of RBE in a spread-out Bragg peak (SOBP) of 200 MeV protons.

Method and Materials: A previously published model converting nanodosimetric data to frequency distributions of double strand breaks (DSBs) of different complexity (number of associated breaks) was used as the starting point. A radiobiological model of cell survival using these frequency distributions and assigning different relative lethality to simple and complex DSBs was developed and model parameters were chosen to reproduce the characteristics of LET-dependent RBE for V79 cell survival. GEANT4 was used to calculate proton spectra at 8 different depths within a 200 MeV SOBP (3 cm width), serving as input to a dedicated Monte Carlo simulation code for nanodosimetry. Cell survival RBE values as a function of proton dose were determined at each SOBP depth.

Results: With an SOPB proton dose of 1.63 Gy (corresponding to a dose of 1.8 GyE for an assumed RBE of 1.1), the predicted RBE for V79 cell survival had an entry value of 1.23, decreasing to a minimum of 1.17 in the SOBP plateau, and then increasing to about 1.25 in the proximal SOBP, followed by an avalanche-type increase to a value of 1.39 at the distal SOPB end.

Conclusions: The depth dependence of V79 survival RBE was predicted using simulated nanodosimetric data within a proton SOBP. We found that the predicted RBE decreased slightly in the SOBP plateau, increased by about 10% in the proximal SOBP, and increased steeply by 20% in the distal SOPB.