AbstractID: 8803 Title: Tumor Volume Simulation in Radiotherapy using Four-Level Cell Population Model

Purpose: To develop a fast computational radiobiological model for qualitative and quantitative analysis of tumor volume variation during fractionated radiotherapy. This model can be used in 4D treatment planning for evaluation of dose variations due to time-dependent density variations in highly conformal radiotherapeutic modalities as IMRT and proton therapy.
Method and Materials: The analysis is performed using two approximations: 1) tumor volume is a linear function of total cell number in tumor and 2) tumor cell population is separated into four subpopulations: oxygenated live and dead cells and hypoxic live and dead cells. The “dead” cells are lethally damaged by radiation and not able to proliferate; however, they stay in the tumor and contribute to the tumor volume until they disintegrate and their debris is removed. The number of living oxygenated and hypoxic cells is governed by the radiobiological mechanisms as LQ survival model, exponential repopulation and reoxygenation. The oxygenated dead cells are removed from the tumor using an exponential decay model.
Results: We have computed tumor volume variation during fractionated radiotherapy for the head-and-neck cancer. The computational results have been compared to the clinical data previously obtained for the head-and-neck cancer using an integrated CT/linear accelerator system. We show that the model predicts the tumor volume variation for the majority of head-and-neck cases. Largest discrepancies between the model and clinical data are obtained during the first days of treatment.
Conclusions: The tumor volume during radiotherapy can be qualitatively described using a relatively simple radiobiological model. The potential impact on the tumor volume of other radiobiological processes which have not been included into the current model as cell cycle analysis, accelerated repopulation and chemotherapy should be studied in the future.

Research sponsored by Elekta corporation.