AbstractID: 3295 Title: A biophysical model for adaptive radiotherapy based on tumor volume regression during radiation treatment

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Purpose

Tumor volume regression is frequently seen during the course of radiotherapy (RT). Adaptive RT (ART) considered so far is mainly geometric, (adapting radiation fields to the changing geometry of the tumor). Biological ART, (adapting radiation dose for individual patients), is the ultimate goal. The purpose of this work is to develop a biophysical model that can be used to biologically adapt RT based on tumor volume regression during the RT treatment course.

Method and Materials

The survival fraction after n fractions can be calculated as $(SF_2 2^{1.4/T_{pot}})^n$, where SF_2 is the surviving fraction at 2 Gy and T_{pot} is the potential doubling time. Based on this expression and other considerations, a formula to relate SF_2 with the residual tumor volume during RT was developed. Two previously reported clinical data sets on tumor volume measurements during RT for cervical were used to validate the model.

Results

The SF_2 can be related to the tumor volume regression during treatment as $(SF_2)_{eff} \equiv SF_2 2^{1.4/T_{pot}} \approx \rho_2 e^{\frac{1}{n}(1-\frac{1}{v_n})}$, where v_n is the relative tumor volume after n fractions, ρ_2 is the relative clonogenic cell density after a 2Gy fraction. The calculation of TCP versus volume regression is consistent with clinical results from two published cervical cancer studies. The calculation of TCP as a function of SF_2 indicates that certain group of patients could benefit from dose escalation. Based on the model developed, we have calculated the extra dose needed to compensate for a poor response to radiation according to tumor volume regression.

Conclusions

A biophysical model that predicts the treatment effectiveness based on the measured tumor volume during the course of RT is developed. The model prediction is consistent with that observed in the clinic for cervical cancer. The model can predict whether the patient would benefit from dose escalation. More clinical data are required to validate our model.