The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Fitting the evolution of glioma's mean radius before and after radiotherapy with a simple biophysical model

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Keywords: *Mathematical modeling, gliomas, radiotherapy, optimization, data analysis*

Diffuse low-grade gliomas are slowly growing tumors that mainly affect adults around 40 years old and are incurable, because they always recur after treatment such as radiotherapy. After tens of years of slow evolution, they transform inexorably into more aggressive forms, jeopardizing the patient's life. Mathematical modeling could help clinicians to have a better understanding of the underlying biological process involved in the evolution of these tumors and their response to treatments. In this work, we show a novel model of the tumor radius evolution before and after the radiotherapy treatment. The model is kept as simple as possible (it has only 5 parameters), yet biologically motivated. In order to confront it with clinical data consisting in time-series of tumor radius from patients [1] (obtained from successive MRI scans), we use a stochastic optimization technique to fit the clinical data of 43 patients.

The first result is that we could obtain very good fits with acceptable values of the parameters for all the 43 patients.

Using the technique of profile-likelihood to extract all the information from the data, we also show that we can build confidence intervals for the tumor birth age and confirm the fact that low-grade glioma seem to appear in the late teenage years. Moreover, an approximate analytical expression of the temporal evolution of the tumor radius allows us to explain the correlations observed in the data [2].

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