Abstract ID: 15048 Title: Toward predicting the location of GBM recurrence after radiotherapy using patient-speci c DTI and numerical modelling

Purpose: Patients diagnosed with glioblastoma multiforme (GBM), the most aggressive form of brain tumour, have a median survival of 15 months when receiving standard treatment. We have developed a three-dimensional reaction-diffusion model which uses patient-specific diffusion tensor imaging (DTI) and real dose distributions to simulate the growth and radiotherapy treatment of a GBM. We highlight paths for tumour recurrence and predict a gain in survival when treatment margins are adjusted according to model inputs.

Methods: A DTI sequence is added to pre- and post-treatment MRI for ten GBM patients receiving standard treatment in our department. Our numerical model uses clinically available images to initialize the tumour cell density and to measure invasion velocity. Patient-specific DTI is used to model tumour cell motility and to prioritize migration along white matter fibres. The treatment dose distribution is used to simulate the radiotherapy treatment actually received by the patient. Finally, we simulate an alternative treatment plan that increases the dose in the region where the model predicts the formation of a recurrent tumour.

Results: The general behaviour of the model was evaluated and found to be adequate for a patient with no DTI but whose post-treatment images were available. For another patient, model initialization with pre-treatment DTI shows that a second tumour focus forms outside the original radiation field in a region where the tumour migration is high due to white matter fibres. The application of an alternative virtual plan integrating the location of the recurrence suggests a 2-month gain of survival time, based on tumour cell density.

Conclusions: Our results indicate that a reaction-diffusion model using patient-specific DTI information could potentially be used to modify GBM treatment margins, leading to an increased survival time. Integrating a long-term outcome study will allow us to verify the predictive efficiency of the model.

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