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Perfusion Kinetics in Human Brain Tumor with DCE-MRI Derived Model and CFD Analysis

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Abstract: Cancer is one of the leading causes of death all over the world. Among the strategies that are used for cancer treatment, the effectiveness of chemotherapy is often hindered by factors such as irregular and non-uniform uptake of drugs inside tumor. Thus, accurate prediction of drug transport and deposition inside tumor is crucial for increasing the effectiveness of chemotherapeutic treatment. In this study, a computational model of human brain tumor is developed that incorporates dynamic contrast enhanced-magnetic resonance imaging (DCE-MRI) data into a voxelized porous media model. The model takes into account realistic transport and perfusion kinetics parameters together with realistic heterogeneous tumor vasculature and accurate arterial input function (AIF), which makes it patient specific. The computational results for interstitial fluid pressure (IFP), interstitial fluid velocity (IFV) and tracer concentration show good agreement with the experimental results. The computational model can be extended further for predicting the deposition of chemotherapeutic drugs in tumor environment as well as selection of the best chemotherapeutic drug for a specific patient.

Keywords: Voxelized model; human brain tumor; arterial input function; perfusion; IFP; IFV; tracer transport; DCE-MRI; CFD