COUPLED FLOW AND TRANSPORT IN THE LIVER ORGAN

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Abstract. In contrast to many other types of cancer, the incidence of hepatocellular carcinoma (HCC) is on the rise. Unfortunately, surgical intervention is not a viable option for most HCC patients, leaving them reliant on chemotherapy treatments, specifically transarterial chemoembolization (TACE), for relief. Since these treatments can potentially obstruct blood flow to healthy liver tissue, there exists a finite number of procedures patients can undergo. Therefore, our study hopes to understand how these treatments unravel in the liver and how they affect the tumor growth. Building upon existing research in the field of computational fluid flow, we aim to model the flow and transport of chemotherapy drugs and embolic agents in the liver. Using CT images of liver cancer patients, we extract a 1D centerline of the hepatic vascular structures that deliver blood to the tumors and then construct a 3D mesh of the liver from the liver segmentation. We use the singularity subtraction technique to model the flow of blood in the liver, specially studying the flow of blood in the parts of the liver that have been affected by the embolic agent. We then extend the singularity subtraction technique to the time-dependent advection-diffusion equation to model the concentration of chemotherapy drugs in the liver and tumors. We obtain optimal convergence rates. The resulting coupled flow and transport model gives us an insight to the evolving dynamics of TACE within the liver. We use this model to evaluate the impact of TACE treatments on HCC tumors, with the hope that it will expose opportunities to improve the efficacy of these treatments in the future.

Keywords: singularity subtraction technique, coupled flow and transport

References

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