A dynamic contrast-enhanced MRI-based data-driven computational technique for early detection of chronic liver diseases

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ABSTRACT

Liver diseases are always on the list of the top ten causes of death in Asian countries. Generally speaking, the progression of liver diseases can be classified into three stages, including liver fibrosis, liver cirrhosis, and liver cancer. One of research focus for clinical practice is to develop some noninvasive technique used for determining the status of the liver disease. Early Diagnosis of the liver fibrosis with some proper treatments can decrease the chance of the Hepatocellular carcinoma happens. In achieving the goal, we propose a data-driven computational technique in conjunction with the dynamic contrast-enhanced MRI (DCI-MRI), which has been shown quite promising for the early detection of chronic liver diseases. The kernel of the proposed technique is a Darcy solver weakly coupled with an unsteady convection-diffusion solver that is used for simulating the blood flows through the liver, assumedly as a kind of porous medium, and the relative signal enhancement scanned by MRI varied in time. Our approach consists of two phases: the offline and online phases. During the offline phase, we correlate the values of the porosity in the mathematical model to the degree of the liver fibrosis, which is determined by the liver biopsy result using the clinical data. During the online stage, to help the doctors' diagnosis, we perform the numerical simulation by using the patient-pacific data to determine the stage of the liver fibrosis. Based on the real clinic data, our data-driven DCE-MRI computational technique achieves about 65% success rate for diagnosing the status of the liver fibrosis correctly.