

# **Quantitative MR imaging: Applications to chronic liver disease and hepatocellular carcinoma**

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Chronic liver disease (CLD), cirrhosis and hepatocellular carcinoma (HCC) remain major health problems in the US and other developed countries. Currently, CLD is diagnosed using a variety of qualitative methods, ranging from physical exam to MR and CT imaging. However, accurate staging of CLD requires liver biopsy, which is expensive, invasive and imposes significant risk of complications such as infection and bleeding. Meanwhile, treatment of HCC - a serious complication of CLD - is often performed through arterial chemoembolization, in which an intravascular catheter is advanced near the tumor and chemoembolic therapy is administered. Upon completion of therapy, patients undergo several follow-up CTs to verify treatment localization and efficacy. Although chemoembolization can be curative for small HCCs, patients are exposed to considerable amounts of ionizing radiation during treatment and follow-up, which increases risk for future tumor development - especially in the background of a cirrhotic liver.

In this dissertation, the use of dynamic contrast-enhanced MRI combined with quantitative perfusion modeling for detection of CLD and assessment of disease severity is investigated. A robust means of hepatic motion compensation (sequential breath holds) is utilized, and a method for fitting a quantitative perfusion model using only motion-compensated data is developed. This method is applied to DCE-MR data from a cohort of 12 volunteers and 10 patients with HCC; differences in perfusion parameters between normal liver, diseased liver and tumor are investigated.

The potential application of fat-water MRI for detection of chemoembolization treatment region and quantification of treatment dose is also investigated. In a small cohort of patients, the feasibility of using IDEAL MRI in place of CT for post-embolization detection of ethiodol distribution is explored. The feasibility of using IDEAL to image ethiodol immediately after intrahepatic injection is also studied in a porcine model.

Finally, because hepatorenal syndrome is often associated with CLD - and may necessitate both liver and kidney transplantation - the use of non-contrast MR angiography to image the transplant renal vessels is studied. Two MRA methods based on Cartesian and radial pulse sequences are compared in a pilot study of 21 renal transplant patients; performance is assessed according to four image quality criteria.