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Magnetic Resonance Imaging for the Assessment of Liver Function

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ABSTRACT

This thesis presents dynamic hepatocyte-specific contrast-enhanced magnetic resonance imaging (DHCE-MRI) as a new method for total and segmental liver function assessment. The method is based on the hepatocyte-specific properties of Gd-EOB-DTPA, which is actively taken up into functioning hepatocytes. The presence of this substance in a tissue will induce an increase in signal intensity in magnetic resonance imaging (MRI). The underlying hypothesis in this work is that if the liver uptake of Gd-EOB-DTPA could be quantified, this would then reflect liver function. All studies were approved by the Stockholm Regional Ethical Review Board. The first study was performed on 20 healthy volunteers and showed that quantification of tracer uptake and liver perfusion was feasible on a segmental level using deconvolutional analysis (DA). In the second study, quantification of tracer uptake was done in 12 patients with primary biliary cirrhosis (PBC) as well as in the 20 healthy controls examined in the first study. Both quantitative parameters derived from DA and traditional semi-quantitative parameters (C_{max}, t_{max}, $t_{1/2}$) were assessed. There were significant differences in the DA-derived parameters regarding uptake capacity and tracer transfer time between PBC patients and controls, but the traditional semi-quantitative parameters were not able to separate the groups. Furthermore, there was a significant association between established prognostic scoring-models and the quantitative parameters. In the third study the healthy volunteers from the first study were again used as controls, but this time compared to 12 patients with primary sclerosing cholangitis (PSC). Total and segmental liver function as well as volume was assessed using DA-derived quantitative parameters, but no significant differences between the groups were found. A significantly more heterogeneous distribution of liver function was found in the PSC group, and the degree of bile duct stricturing so typical of PSC was found to correlate with the DA-derived liver function parameters. In the fourth study total and segmental liver function was assessed in 10 patients with varying degrees of alcohol- and/or viral-induced cirrhosis, and compared to the controls of the first study. Also in this patient group a significantly more heterogeneous distribution of liver function was found, as well as significant differences between the groups regarding the outcome of the functional parameters. In a simulation of a left hemihepatectomy, the possible implication of this heterogeneous distribution of function on liver resection was assessed, showing how uncertain the prediction of postoperative liver function can be when regional differences in liver function are not accounted for. In a receiver operator characteristic (ROC) analysis, the DHCE-MRI derived parameters showed good to excellent capacity in separating groups with normal or adequate liver function from patients with more severely affected liver parenchyma.

In conclusion, DHCE-MRI can be used to assess total and segmental liver volume and function. Functional parameters indicative of parenchymal tracer extraction capacity, liver perfusion and tracer transit times can also be assessed on a global and segmental level. The outcome of these parameters differs significantly between patients with liver cirrhosis and healthy controls, and also correlates with established clinical scoring models. DHCE-MRI is a new and promising tool for total and segmental liver function assessment and deserves further studies.

Key-words: DHCE-MRI, liver function, Gd-EOB-DTPA, deconvolutional analysis

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