

Combined MRA and DCE perfusion imaging of the liver using an IVD acquisition and HYCR reconstruction with a single contrast injection

James H Holmes¹, Kang Wang¹, Mahdi S Rahimi², Frank R Korosec^{3,4}, Lauren A Keith⁴, Jens-Peter Kühn^{3,5}, Scott B Reeder^{3,4}, and Jean H Brittain¹

¹Global Applied Science Laboratory, GE Healthcare, Madison, WI, United States, ²Biomedical Engineering, University of Wisconsin-Madison, Madison, WI, United States, ³Radiology, University of Wisconsin-Madison, Madison, WI, United States, ⁴Medical Physics, University of Wisconsin-Madison, Madison, WI, United States, ⁵Department of Diagnostic Radiology, University Greifswald, Greifswald, MV, Germany

Introduction: The current clinical standard of care currently requires separate DCE and MRA acquisitions to evaluate liver lesions and vasculature. Recent advances in dynamic imaging including the IVD (Interleaved Variable Density) sampling pattern and HYCR (Highly constrained Cartesian Reconstruction) techniques have pushed the limits of simultaneous high temporal and spatial resolution [1,2]. In this work, we present the use of IVD and HYCR for time-resolved imaging to provide both MRA and DCE perfusion assessment of the hepatobiliary system in a single acquisition. This provides advantages in terms of limiting exam time and injected contrast dose as well as providing co-registered vascular and perfusion maps to more readily identify feeding arteries of lesions to facilitate treatment planning.

Methods: 16 Volunteers were imaged on a clinical 3T MRI system (DVMR750, GE Healthcare, Waukesha, WI) with a 32-channel phased array coil. Volunteers received a single contrast injection of either 0.1mmol/kg of gadobenate dimeglumine (Multihance, Bracco, Princeton, NJ) administered at 3mL/s or 0.05mmol/kg of gadoteric acid (Eovist, Bayer-Schering AG, Germany at a flow rate of 2 ml/sec. Data were acquired using the IVD time-resolved sampling scheme with a 3D spoiled gradient echo sequence, flip angle = 12°, FOV of 40 x 40 x 23 cm³, and true spatial resolution of 1.2 x 1.2 x 2.1 mm³. A fractional echo acquisition was performed with TE of 1.3 ms. No fat suppression was performed to minimize the TR to 3.8 ms thereby maximizing the acquired frame rate. Images were reconstructed at a theoretical temporal resolution of 4 sec/time frame using the HYCR method combined with coil-by-coil data driven parallel imaging (ARC [3]). To minimize motion artifacts, volunteers were asked to perform multiple consecutive 20s breath-holds during the predicted arterial phase, portal-venous phase, and equilibrium phase corresponding to 10s, 1 min, and 2 min post-injection. During image reconstruction, no data were shared between the separate breath-holds to minimize data inconsistencies due to variations in breath-hold position.

Results: Example MRA and DCE images are shown in a healthy volunteer receiving a single contrast injection (Fig. 1). Limited MIP projections during the peak hepatic artery (Fig. 1a) and portal venous (Fig. 1b) phases allow visualization of the vasculature and filling patterns of the liver. A single slice from the 3D volume depicting the late hepatic arterial phase provides visualization of early enhancing perfused features (Fig. 1c) and a portal venous phase image allows assessment of perfusion washout (Fig. 1d).

Conclusions: In this work we demonstrated the feasibility for using the IVD HYCR time-resolved method in a single comprehensive contrast enhanced acquisition to acquire both high resolution angiograms as well as high temporal resolution DCE perfusion imaging of the liver. This provides advantages in terms of fewer contrast injections and lower scan times. Further, the method more readily provides registered MRA assessment of vasculature with evaluation of perfusion for detection of lesions in surgical planning and therapeutic planning including TACE (trans-arterial chemoembolization). For this work, no fat suppression was used to maximize the temporal/spatial resolution. There is no reason this could not be added, however, it would come with a modest reduction in acquisition speed.

Acknowledgements: We gratefully acknowledge support from the NIH (R01 DK083380, R01 DK088925 and RC1 EB010384) and departmental R&D funding.

References: [1] Wang et al. MRM 2011;66:428-436 [2] Wang et al. ISMRM 2011, A3459 [2] Brau et al. MRM 2008; 59:382-395

