Clinical Assessment of a Non-contrast MR Angiography Protocol for the Pre-Transplant Evaluation of the Liver Vasculature

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Purpose: Contrast-enhanced MR angiography (CEMRA) is an accepted reference standard for the pre-transplant evaluation of the hepatic vasculature (1-3). Given the prevalence of renal insufficiency in this patient cohort, a non-contrast alternative is needed to evaluate vascular anatomy, patency and detect significant extrahepatic portosystemic shunts. Doppler sonography has demonstrated utility in assessing portal flow directionality; however, this modality is limited in the assessment of variceal flow. As liver transplant recipients with extrahepatic portosystemic shunts greater than 1 cm in size have increased graft complications, robust diagnostic tests to identify these shunts pre-transplantation is vital (4). In addition, portal vein thrombosis is a relative contraindication to liver transplantation; accurate assessment of the residual portal vein lumen and identification of patent intrahepatic portal branches enables transjugular intrahepatic portosystemic shunt with portal thrombectomy pre-transplant. We have assessed a comprehensive non-contrast MRA (NCMRA) protocol to evaluate the liver vasculature to determine suitability for liver transplantation. This protocol combines native TrueFISP, quiescent interval single shot (QISS) MRA and MRV, and 3-D short tau inversion recovery (STIR) imaging to enable visualization of the hepatic arteries, hepatic veins, as well as the portal, mesenteric, and splenic veins. We hypothesize that this NCMRA protocol will delineate the liver vascular anatomy and identify significant extrahepatic portosystemic shunts (>1cm) when compared to CEMRA in all subjects.

Methods: 20 patients (12 men, avg age 53.2 ± 8.0 yrs) with liver cirrhosis and portal hypertension were prospectively recruited under an IRB-approved protocol. All subjects underwent MR imaging at 3.0T (Magnetom Skyra, Siemens Medical Systems, Erlangen, Germany). Hepatic arterial anatomy was evaluated using 2D QISS MRA applied using a venous saturation pulse as well as native TrueFISP with respiratory bellows, a single axial saturation slab positioned over the porta hepatis, and a patient-specific inversion time between 1600 and 2000 msec. Hepatic venous anatomy was evaluated using native TrueFISP with respiratory bellows, an axial saturation band positioned over the liver parenchyma, and an inversion time of 1300 msec as well as coronal 3D STIR imaging. Portal and mesenteric venous anatomy and patency were evaluated on the coronal 3D STIR sequence as well as axial and doubly obliquued (orthogonal to the portal vein) 2D QISS MRA without a flow sensitive suppression pulse. All subjects underwent multiphase first pass contrast-enhanced MRA (CEMRA) with breath-holding, using 0.03 mmol/kg of gadofoveset trisodium (Ablavar, Lantheus Medical Imaging, Minneapolis, Minnesota) administered as a bolus at 2mL/sec. A single reviewer independently evaluated NCMRA and CEMRA datasets for hepatic arterial and venous anatomy, as well as portal and mesenteric venous patency. Spontaneous portosystemic shunts > 1 cm in size were noted. Each NCMRA sequence was scored as evaluable or non-evaluable. The reviewer noted when none of the NCMRA sequences were evaluable for a region of the vascular anatomy (hepatic artery, hepatic vein, or portal venous system) and considered this a non-diagnostic NCMRA exam. CEMRA was considered the gold standard for evaluating the NCMRA protocol; when individual NCMRA sequences differed in vascular assessment, the result of the technique demonstrating the least amount of disease was taken as the outcome of the NCMRA protocol.

Results: All subjects successfully completed the study protocol. The NCMRA protocol was diagnostic in 19 patients (95%); in one subject an irregular breathing pattern precluded hepatic arterial and hepatic venous assessment, while limiting portal venous assessment. In the remaining 19 subjects, hepatic arterial anatomy, hepatic venous patency, and portal venous patency as assessed using the NCMRA protocol demonstrated perfect agreement with CEMRA (Figure 1). Four portosystemic shunts > 1cm in size were correctly characterized at NCMRA.

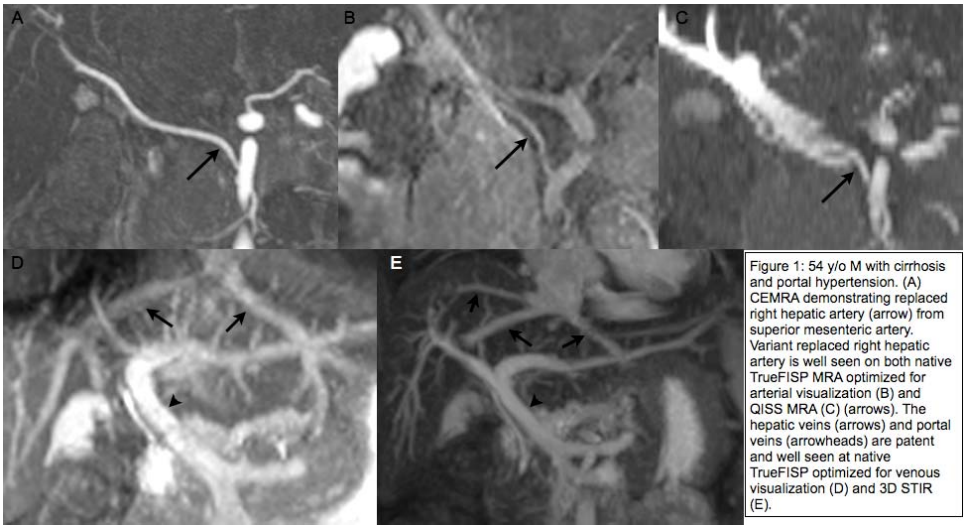

Figure 1: 54 y/o M with cirrhosis and portal hypertension. (A) CEMRA demonstrating replaced right hepatic artery (arrow) from superior mesenteric artery. Variant replaced right hepatic artery is well seen on both native TrueFISP MRA optimized for arterial visualization (B) and QISS MRA (C) (arrows). The hepatic veins (arrows) and portal veins (arrowheads) are patent and well seen at native TrueFISP optimized for venous visualization (D) and 3D STIR (E).

Discussion/Conclusion: Our results suggest that a NCMRA liver vascular protocol utilizing multiple complementary non-contrast imaging techniques demonstrates promise for the comprehensive pre-transplant hepatic vascular evaluation in patients with cirrhosis and portal hypertension. Patient recruitment is on-going to validate these preliminary results in a larger patient cohort, determine performance detecting complete and partial portal thrombosis, and improve accuracy in subjects with irregular breathing or large volume ascites.

References: 1. Erden A, et al. Clin Imaging. 2003;27(2):101-5. 2. Liu H, et al. Hepatobiliary Pancreat Dis Int. 2005;4(2):239-43. 3. Vermeulen MA, et al. EJR. 2011;1:1. 4. Horrow MM, et al. J Ultrasound Med. 2010;29(1):125-8.