

# Feasibility of 3.0T MR Angiography For Pre-Operative Vascular Evaluation of Pediatric Patients Undergoing Liver/Small Bowel Transplantations.

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## Background:

Organ transplantation offers a definitive management option in end stage chronic liver and intestinal disease. Acquired and congenital vascular anomalies may preclude transplantation or require a modification of the standard surgical procedure. Biliary atresia remains the main indication for pediatric liver transplantation (LT) and is associated with anatomic and pathologic variations of the liver vasculature in 29% of cases (1). Hence, confirmation of the patency and anatomy of the vascular structures is a paramount prerequisite. Before 2001, conventional angiography was the standard imaging modality to assess the vascular system. More recently computerized tomography angiography (CTA) has been used in the adult patients. Both techniques subject patients to high levels of ionizing radiation and iodinated contrast hazards that are especially of concern in the pediatric patients. Magnetic resonance imaging and angiographic techniques (MRA) techniques provide non-invasive and comprehensive diagnostic alternatives in pre-transplantation evaluation.

The aim of this study was to evaluate the accuracy of contrast enhanced high-resolution MRA (CEMRA) using a 3.0T system for pre-operative evaluation of pediatric cases undergoing liver/small bowel transplantation.

## Methods:

This study represents a retrospective analysis of imaging findings in 8 patients who underwent CEMRA for solitary or combined liver and small bowel pre-transplantation evaluation between August 2008 and October 2010. All studies were performed under general anesthesia for sedation and respiratory control. Consents were obtained prior to anesthesia.

All studies were performed on a 32-receiver channel 3.0T whole body MR system (Magnetom Trio, Siemens Medical Solutions, Erlangen Germany). Depending on the patient's size, head, neck or body coils were used. Typical imaging protocol involved multiplanar T2-weighted HASTE sequences, pre-contrast axial and coronal 2D GRE sequences and initial sagittal aortic timing run. Gadolinium enhanced high resolution MR angiographic images of the thorax and central vessels were acquired with subsequent early and systemic phase imaging. No contrast was given during the second or third passes.

A cardiovascular radiologist evaluated the quality of images, and the ability of the study to adequately demonstrate vascular structures. The overall quality of CEMRA studies was graded as low, medium, high. A high quality study was defined when the vascular structures were well delineated with minimal imaging artifacts (ie. movement or mixed signal artifacts). A low quality study was defined when the vascular structures were poorly delineated due to the lack of contrast, or when imaging artifacts significantly compromised the quality. The confidence of the observer to evaluate the patency of vessels (patent, occluded, stenosed/partially thrombosed, unknown) and to recognize vascular anomalies was graded. The confidence was graded as 1. Very confident, 2. reasonably confident and no need for further investigation, 3. low confidence with need for further studies, 4. no confidence. The observations were qualitatively analyzed. The following anatomical structures were examined: abdominal aorta, celiac axis, superior mesenteric artery, inferior mesenteric artery, hepatic artery, portal and hepatic veins. All the vessels were examined in terms of patency and anatomical anomalies and the observer's confidence was graded as described earlier.

## Results:

Eight transplant candidates (3 liver, 2 small bowel, and 3 combined recipients) were investigated by CEMRA. Patients' age ranged from 5 months - 13 years (median: 11 months). Their weight ranged from 5-72 kg (mean: 19 $\pm$ 22). The average volume of intravenous contrast agent used was  $0.38 \pm 0.14 \text{ mL} \cdot \text{kg}^{-1}$  (total mean volume:  $5.7 \pm 4 \text{ mL}$ ). The rate of contrast injection was  $0.4\text{-}0.6 \text{ mL} \cdot \text{sec}^{-1}$ . The total scan time was  $55 \pm 13 \text{ min}$ . This included the time allowed for added examinations (ie. brain MRI or MRCP) and interventional procedures (liver biopsy) in 7/8 patients. Background liver diseases included: biliary atresia (n=2); TPN related cholestasis (n=3); portal venous thrombosis (n=1). Indications for small bowel transplantation were malrotation (n=2), megacystis hyperperistalsis (n=2), and necrotizing enterocolitis (n=1).

Three phase (arterial, early and late systemic) CEMRA studies were performed in 6 cases, and two-phase studies in 2. All arterial structures were confidently observed in all patients. The average quality of arterial study was very high in all cases. Inferior mesenteric artery could not be identified in two cases. All other main branches of the abdominal artery were confidently identified. Hepatic arterial variants were noted in 4 cases (Figure 2). Portal veins could not be identified in one case indicating venous thrombosis. The hepatic veins could not be confidently evaluated in the two cases in whom the delayed systemic phase imaging was not performed.

## Conclusion:

High-resolution CEMRA using a 3T MR system that was performed under controlled ventilation was feasible in pediatric patients undergoing evaluation for single or multivisceral transplantation. Contrast injection was well tolerated and produces high quality examinations from either peripheral or central venous administration. Additional MRI sequences can be added for dedicated evaluation of other organs.

Reference: 1) Tanano et al. J Pediatr Surg 1999; 34: 1687.

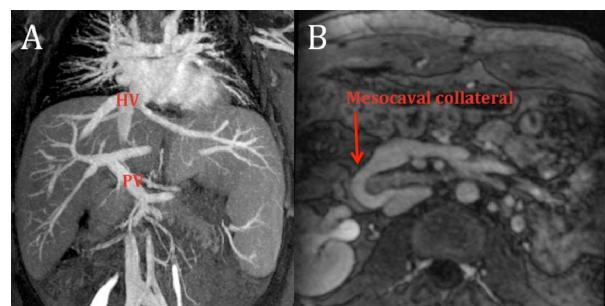


Figure 1: Hepatic venous anatomy.

(A) MIP coronal reformats of systemic phase CEMRA showing normal hepatic and portal veins (HV; PV).  
(B) Mesocaval shunt in a patient with portal thrombosis.

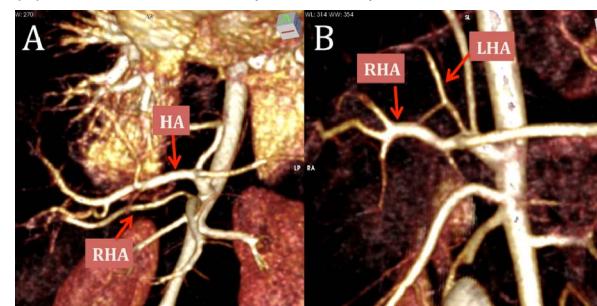


Figure 2: Volume rendered MRA showing alternative hepatic arterial anatomy.

(A) accessory right hepatic artery (RHA) originating from the SMA. (B) separate origins of the right and left hepatic arteries from celiac trunk.