Clinical Experience with Gadoxetate-Enhanced T1 Weighted Hepatobiliary Imaging in Primary Sclerosing Cholangitis

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Introduction: Primary sclerosing cholangitis (PSC) is a chronic inflammatory condition of the extra- and intra-hepatic biliary ducts that results in a classic beaded appearance of the biliary tree due to alternating strictures and dilatations. The exact etiology is unknown and the disease can progress to cirrhosis and liver failure, with liver transplantation often the only definitive treatment. Heavily T2-weighted magnetic resonance cholangiopancreatography (T2-MRCP) is an effective, noninvasive imaging method for diagnosis and evaluation of PSC [1]. With the recent FDA approval of gadoxetate (Gd-EOB-DTPA, Eovist, Bayer Pharmaceuticals, Wayne, NJ), a hepatobiliary contrast agent with 50% biliary excretion, and development of optimized high-resolution T1-weighted sequences for imaging gadoxetate-enhanced livers [2], there are new opportunities to evaluate the biliary tree with T1-weighted 3D MR cholangiography (T1-MRC) in PSC. The purpose of this work is to evaluate the added diagnostic clinical utility of using high spatial resolution, gadoxetate-enhanced 3D T1-MRC compared to 3D T2-MRCP, in patients with PSC.

Methods: After obtaining IRB approval, a retrospective study was performed in 29 patients with 34 MRI exams of the liver in patients imaged between September 2008 and September 2009. All patients with a known or suspected diagnosis of PSC and were imaged with both T2-MRCP and high resolution gadoxetate-enhanced T1-MRC.

All imaging was performed at 1.5T (TwinSpeed HDx, GE Healthcare, Waukesha, WI) using an 8-channel cardiac or torso phased array coil and investigational 3D T2-MRCP and 3D T1-MRC acquisitions. Free-breathing respiratory triggered 3D T2-MRCP images were acquired prior to the administration of contrast, and specific imaging parameters included: coronal oblique slab, FOV=32 cm, TEeff=762 ms, 288 x 288 matrix with 60 slices, slice thickness=1.8 mm, and BW=±31.25 kHz. Fat and vessel suppression were enhanced through use of a T2Prep preparation pulse [3]. A 2D parallel imaging method (ARC) [4] was used to accelerate the acquisition time with an acceleration factor of 1.81. Total scan time was 3-5 minutes.

High resolution navigator 3D T1-MRC imaging was performed 20 minutes after the injection of 0.05mmol/kg gadoxetate during the hepatobiliary phase using a recently described optimized high resolution, T1 weighted, navigator based, 3D spoiled gradient echo (SPGR) with intermitent spectrally selective partial inversion recovery fat suppression [2]. Specific imaging parameters include: axial slab, FOV=35cm, TR/TE=5.8/2.7ms, 288 x 256 matrix with 108 slices, slice thickness=1.8mm, and BW=±41.67 kHz. A flip angle of 40° was used to maximize contrast between the bile ducts and the liver as previously shown [2]. Although this sequence is compatible with ARC, no parallel imaging acceleration was used to maximize SNR performance. Total scan time was 5-6 minutes.

A total of 29 patients with 34 exams (5 patients have follow-up exams) were included. Age range was 16-81 (average=45), and 19 males, 10 females. Two experienced fellowship-trained abdominal imagers independently reviewed the 3D T2-MRCP and 20 minute delayed gadoxetate-enhanced 3D T1-MRC images for each study. T1-MRC and T2-MRCP acquisitions were evaluated concurrently on PACS (McKesson, San Francisco, CA) using a subjective 3-point scale for duct visibility (0-nonvisualized, 1-poor visualization, 2-acceptable visualization, 3-excellent visualization), a 3-point scale of overall exam quality (0-nondiagnostic, 1-poor, 2-average, 3-excellent), and a 3-point diagnostic “helpfulness” scale to assess the added information from the gadoxetate-enhanced T1 weighted images (0-not helpful, 1-confirmatory or mildly helpful, 2-moderately helpful, 3-very helpful). Overall preference for T1-MRC vs T2-MRCP was also evaluated.

Results: An example of T2-MRCP and the corresponding T1-MRC images are shown in figure 1, in a patient with severe PSC demonstrating excellent subjective anatomical concordance between the two methods, with the typical features seen with PSC seen in both imaging methods.

Reviewers found gadoxetate-enhanced T1-MRC to be moderately or very helpful in 76% of the cases while in 24% of the cases helpfulness was deemed minimal to non-existent. The T2-MRCP was preferred 61% of the time while T1-MRCP was preferred 39% of the time.

Preliminary results indicate that gadoxetate-enhanced T1-MRC was highly complementary to T2 weighted MRCP imaging, but would not replace conventional T2-MRCP. Not only did T1-MRC often provide functional information for obstructed bile ducts but it also provided a “second” look at bile duct anatomy, providing additional visualization of pathology not seen well with T2-MRCP. Central stenoses often appear more severe with T2-MRCP relative to T1-MRC, suggesting that T2-MRC may exaggerate the appearance of strictures. In 7 cases the gadoxetate-enhanced images demonstrated no biliary enhancement peripheral to the stenotic segment. While this suggests a very severe, functionally relevant stenosis, it also does not provide visualization of these ducts. Thus the T1-MRC and T2-MRCP images are highly complementary.

Discussion: This clinical study demonstrates that high-resolution 3D T1-weighted gadoxetate-enhanced hepatobiliary phase MR cholangiography is an excellent adjunct to 3D T2 weighted MRCP. Not only do gadoxetate-enhanced images provide anatomical visualization of biliary tree and associated disease but also offer useful functional/physiologic information that was tremendously helpful in many cases. The combination of T1-MRC and T2-MRCP is used routinely in our clinical practice for the evaluation of PSC. Ongoing work will compare the utility of T1-MRC and T2-MRCP with ERCP (available in 9 of the patients in this study).


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