

Clinical evaluation of an ultra high spatio-temporal resolution time resolved dynamic contrast enhanced imaging technique in hepato-biliary oncosurgical imaging

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Introduction: Hepato biliary MR examinations today involve a high quality MRCP scan which serves as a road map of hepato biliary and pancreatic ductal tree showing their normal anatomy or disease by demonstrating obstruction, its level and to some extent its nature. However, MRCP alone is insufficient in hepato biliary oncology. Multi-phasic dynamic contrast enhanced imaging (DCE-MRI) can enable characterization of lesions and pre-operative staging by its ability to detect metastases in liver, nodes, etc but faces the following challenges: 1. inadequate spatial coverage of the hepato biliary tree, pancreas, duodenum 2. inadequate temporal resolution to characterize contrast uptake of tumors as they enhance in different phases 3. unreliable capture of the true arterial phase 4. Pre-operative surgical planning and visualization of liver lesions and vascular tree using surgeon friendly reformats. Hence, there is a felt need for a fast, multiphase sequence with high spatio-temporal resolution that reliably captures the true arterial phase and affords excellent volume MIP reformats of vascular anatomy. The purpose of this clinical study was to evaluate the usefulness of a novel fat suppressed DCE-MRI sequence with ultra high spatio-temporal resolution in hepatobiliary and pancreatic imaging practice, as a useful adjunct to MRCP.

Methods: All imaging was done on a 1.5 T GE Signa Excite scanner using a 8-channel phased array coil. DCE-MRI was performed using an elliptic centric (EC) fat suppressed time resolved spoiled gradient echo sequence (FSTRICKS) which has hitherto been used only for MR angiography. Simulations showing the possibility of using this technique for DCEMRI have been presented earlier [1]. A novel EC compatible fat saturation technique [2] was used for effecting fat suppression, where the play-out rate of the fat suppression pulses was varied as a function of k_r , the radial distance, minimizing ghosting and providing optimal fat suppression. Parallel imaging (ASSET) was added to double the temporal resolution and halve BH times. Thirty-eight patients with obstructive jaundice and MRCP evidence of biliary and pancreatic ductal obstructions and strictures were included in the study after prior informed consent. The age range was 35-75 years and male/female ratio 5:2. All patients underwent 2D and 3D MRCP exams followed by DCE-MRI after intravenous administration of 10-15cc gadolinium contrast. The sequence parameters were as follows: 15° flip, \pm 62.5 KHz BW, TR/TE 3.9/1.4 ms, 36x36 cm FOV, 192x192 matrix, 3.6mm thick, 0.75NEX. Four short breath-holds of 13s each was used to reconstruct 10 temporal phases using TRICKS reconstruction, yielding a true temporal resolution of 6.5s. The data were then reformatted and MIPS were generated to depict the vascular anatomy.

Results: In all the cases (n=38), we successfully obtained the pre- and the true arterial phase of the liver followed by the other vascular phases. This was one of the desired goals for accurate staging of the hepato biliary tumors from a surgical perspective. High ductal cholangio carcinoma (n=5) showed delayed enhancement beginning from phase 7 to 10, distal ductal cholangio carcinoma (n=7) showed nodular intramural enhancement of CBD wall, periampullary carcinoma(n=8) showed intra luminal CBD enhancement and ampullary enhancement with double duct sign, pancreatic head carcinoma(n=10) showed variable enhancement of distal CBD and proximal MPD and double duct sign, invasive gall bladder cancers (n=8) showed delayed enhancement in phase 8, 9, and 10. Hepatic metastases were detected and characterized in 16 cases(pancreatic cancer 7, GB cancers 4, periampullary carcinoma 5). Ascites with delayed peritoneal metastatic enhancement was detected in 10 cases (4 pancreatic, 2 high ductal cholangio, 3 gall bladder, 1 distal ductal cholangio carcinoma). Porta hepatic hepato duodenal ligament lymphadenopathy was detected in 5 cases. All findings from DCE-MRI were confirmed using histo-pathology following surgery.

Conclusions: We have validated the use of a novel sequence with high spatiotemporal resolution as a powerful adjunct to MRCP for detection, characterization and accurate preoperative staging of hepato biliary tumours for the oncosurgeon. Robustness to motion, ability to capture the true arterial phase in liver imaging followed by multiple phases and the ability to generate the vascular tree using reformation MIPS make it a very powerful and valuable tool in hepatobiliary MRI.

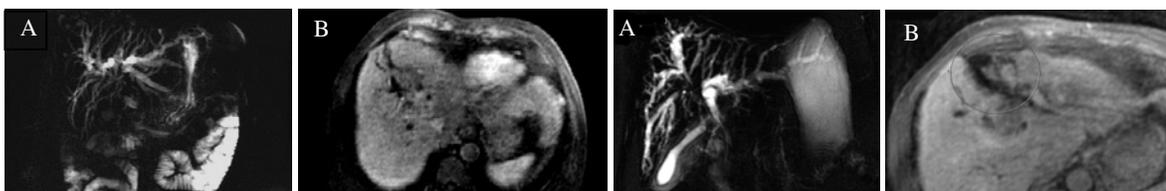


Figure 1. High ductal cholangio on MRCP with obstruction of CHD and confluence of RHD/LHD (a). Late phase FSTRICKS image showing delayed enhancement of hilar cholangio carcinoma (b).

Figure 2. Thick slab MRCP of invasive gall bladder carcinoma with direct contiguous extension on to CHD and porta with porta hepatic lymphnodes with high portal block (a). Phase 10 of FSTRICKS with delayed enhancing intra-luminal gall bladder mass (b)

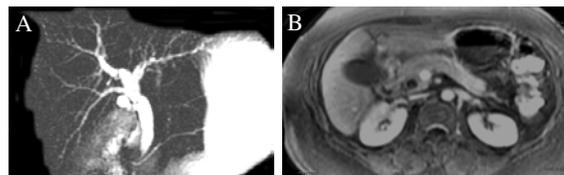


Figure 3. Distal CBD cholangio carcinoma on 3D MRCP (a). Enhancing intra-luminal small CBD mass on delayed phase 7 of FSTRICKS (b)

References: 1. Saranathan et al. Proc. 13th ISMRM p. 2721 (2005). 2. Foo et al. Proc. 13th ISMRM, p. 2206 (2005).