High-resolution 3D-TrueFISP with integrated parallel imaging technique for MR-enteroclysis in patients with small bowel disease

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Purpose:
Integrated parallel imaging techniques (iPAT) are designed to increase spatial resolution while reducing acquisition time[1]. With the introduction of 32-channel-whole body MR-scanners, iPAT with high acceleration factors and in two dimensions has become applicable also to abdominal imaging. For small bowel imaging and MR enteroclysis (MRE) in particular, a steady state free precession sequence (TrueFISP) is preferentially used and highly recommended [2, 3]. 2D iPAT at a total nominal acceleration factor of six enables the acquisition of a 3D-TrueFISP data set with isotropic voxel size of 1.8x1.8x1.8mm³ in one breath hold of 18 seconds. The present study is designed to evaluate the advantages and additional diagnostic impact of high-resolution 3D-TrueFISP and 3D-post-processing with multi-planar (MPR) and curved reformats (CR) in small bowel imaging with MRE.

Patients and Methods:
Twenty-two patients addressed for suspected or proven Crohn’s disease underwent MRE after trans-duodenal intubation and instillation of 2.5 l of aqueous methylcellulose-suspension. All images were acquired on a 32-channel whole-body MR-scanner (Magnetom Avanto [76x32], Siemens Medical Solutions, Erlangen, Germany) using a total of 24 array coil elements arranged in four rings, each comprising 3 anterior array and 3 posterior spine array elements. Half-Fourier single shot turbo spin echo (HASTE) and T1w post-contrast gradient echo (GRE) sequences were used as standard of reference for confirmation of pathologic findings. 3D-TrueFISP imaging was acquired with 2D-iPAT applying a total acceleration factor 6 (iPAT factor of 3 in left-right phase-encoding direction and iPAT factor of 2 in anterior-posterior partition direction, Figure 1) resulting in an isotropic voxel size and a spatial resolution of 1.8x1.8x1.8mm³. The other sequence parameters were: TR 4.3ms / TE 1.9ms / Flipangle 70° / FOV 450x450mm² / Matrix 256x256 / Bandwidth 528 Hz/Pixel. Image reconstruction in phase-encoding direction was based on the GRAPPA-algorithm[1, 4]. For image reconstruction in the partition direction a SENSE-like algorithm was used[1]. To assess the supplementary diagnostic information from 3D TrueFISP data, MPR and CR reformats (Figure 2) were generated and evaluated by two board certified radiologists in consensus grading the additional diagnostic impact in none, minor and major.

Results:
MPR and CR from high-resolution 3D-True FISP imaging added valuable information in 17/20 patients (77.3%): better assessment of length and degree of stenosis (Figure 2) as well as skip lesions (10/22), mucosal changes (3/22) and bowel involvement in complex fistulae (2/22) in patients with CD and better assessment of tumor margin and infiltration in 2 patients with small bowel malignancy. Additional diagnostic Information was rated “major impact” in 54.6% of cases (95% Confidence interval (CI): 32.2%–75.6%) and “minor impact” in 22.7% (95% CI: 7.8% – 45.4%). In 22.7% of the cases reformats confirmed the findings in the standard of reference.

Conclusion:
MPR and CR from isotropic 3D-TrueFISP imaging can improve and refine the diagnosis based on MRE in the assessment of Crohn’s disease and other small bowel pathologies. Higher iPAT factors are a prerequisite for the successful application of this technique.

Figure 1: Graph of 2D iPAT with acceleration factor of 6

Figure 2: Curved reformat in a patient with terminal ileitis: better assessment of length of stenosis and prestenotic dilatation