Depiction of Non-Dilated Intrahepatic Bile Duct by High Spatial Resolution 3D MR Cholangiography using SPACE at 3 T; Comparison with 1.5 T in Healthy Volunteers

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Introduction

SPACE (Sampling Perfection with Application optimized Contrasts using different flip angle Evolutions) is a new technique that could overcome specific absorption rate (SAR) problem on 3D turbo-SE (TSE) sequence at 3 T. The use of SPACE sequence, which gathers high signal intensity only for the echoes applied to acquire the low phase-encoding steps by using variable refocusing flip angle (FA), allows a significant reduction in SAR, while maintaining better signal-to-noise ratio (SNR) produced by 3 T. Applying the SPACE technique at 3 T, we can obtain high spatial resolution 3D MR cholangiography (MRC) without running into SAR problem; which could potentially depict non-dilated peripheral intrahepatic bile duct (IHBD) not visualized on MRC at 1.5 T, and may provide detailed anatomic information and small pathologies of the biliary tract. The aim of this study was to evaluate image quality, especially the visibility of non-dilated IHBD, using 3D MRC with SPACE compared to 3D MRC with conventional constant refocusing FA at both 3 T and 1.5 T.

Materials and Methods

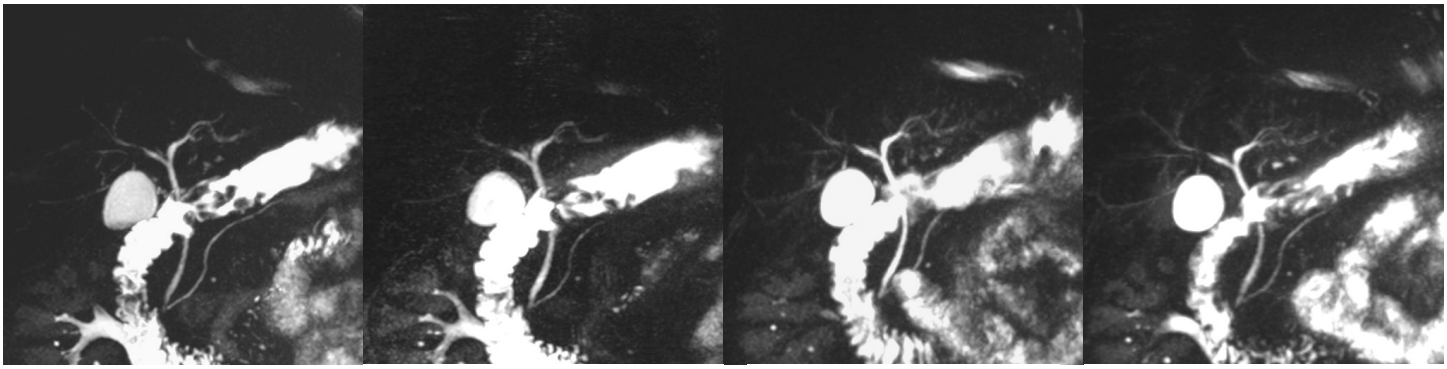
Eighteen healthy volunteers (11 men, 7 women; age range, 26-57 years) were examined at both 3 T and 1.5 T MR scanners. MRC images were obtained with free-breathing navigator-triggered 3D T2-weighted TSE sequences using SPACE at both 3 T and 1.5 T (TE, 780 ms for 3 T and 801 ms for 1.5 T; FA, variable; ETL, 121; parallel acquisition technique factor, 3; voxel size, 1.0 × 1.1 × 0.8 mm^3); and with free-breathing navigator-triggered 3D T2-weighted TSE sequences using constant refocusing FA at both 3 T and 1.5 T (TE, 786 ms for 3 T and 740 ms for 1.5 T; FA, 150° at 3 T and 180° at 1.5 T; ETL, 129; parallel acquisition technique factor, 4; voxel size, 1.0 × 1.1 × 0.8 mm^3). To stay within the accepted SAR range, FA was decreased on constant FA sequence at 3 T compared to 1.5 T. Prospective acquisition correction (PACE) technique was used in each sequence to correct respiratory motion. Maximum intensity projection (MIP) images were generated from each multislice data set on a workstation, and both the source and MIP images from each sequence were used for qualitative analyses. Overall image quality and visualization of the third branches of IHBD (B2, B6 and B8) were graded on a 5-point scale, and depiction of cystic duct insertion was graded on a 3-point scale. The highest order of IHBD visible was also recorded. Common bile duct (CBD) to liver contrast-to-noise ratios (CNR) were measured for quantitative assessment.

Results and discussion

MRC images with SPACE sequence at 3 T allowed significant improvement in overall image quality and visualization of B2 compared with the other three sequences ($p < .05$). In all analyses of duct visibility, SPACE at 3 T showed higher scores than the other three sequences. As above, we have shown a marked improvement in the visibility of the non-dilated IHBD on SPACE-using MRC at 3 T compared to 1.5 T. On the other hand, there was no significant difference in duct visibility between images with constant FA sequence at 3 T and at 1.5 T. This seems to be inconsistent with a recent report (1). Because a higher spatial resolution and larger slice numbers were adopted in our study compared to the reported study, the FA had to be decreased to 150° from the ideal FA of 180° at 3 T due to SAR limitation. It is possible to assume that the nonimprovement in duct visibility on constant FA sequence at 3 T is due to this decrease in FA. These qualitative results are also supported by the result of CNR measurements; CNRs between CBD and liver on SPACE sequence were significantly higher at 3 T than at 1.5 T ($p < .05$), while no difference among 3 T and 1.5 T was seen on constant FA sequence. In contrast, with the use of the SPACE technique, we were able to obtain high quality 3D MRC with otherwise identical parameters (high spatial resolution and large slice numbers) to the constant FA sequence without running into SAR problems even at 3 T. These results suggest that the SPACE technique should be employed for 3D MRC to realize the advantage of 3 T, especially when a high spatial resolution and high volume coverage are adopted, which necessitate a reduction in FA with the conventional constant FA sequence.

Conclusion

High spatial resolution 3D MRC using SPACE at 3 T allows high-quality images of biliary tract, and has the ability to depict non-dilated peripheral IHBD.



SPACE sequence at 3 T Constant FA sequence at 3 T SPACE sequence at 1.5 T Constant FA sequence at 1.5 T

(1) Merkle EM, et al. 3.0- versus 1.5-T MR cholangiography: a pilot study. AJR Am J Roentgenol 2006;186:516-521.