3D Breath-Hold Fat-Suppressed T1-Weighted Abdominal MRI at 3.0 Tesla

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Introduction

Comprehensive abdominal MR imaging exams require contrast-enhanced, fast 3D imaging for evaluation of diseases in both solid organs and vessels [1,2]. Early 3D gradient echo (GRE) limitations at 1.5 Tesla were overcome by sequence optimization to produce high-resolution images with good fat suppression and adequate anatomic coverage within a breath-hold [3]. At 3.0 Tesla, though, our vendor-provided sequence had to be significantly altered, enhanced and optimized to achieve comparable image quality and efficiency. We demonstrate that good quality breath-hold images can be obtained using the body coil at 3.0 Tesla. More importantly, we show the feasibility and potential of 3.0 Tesla, body coil, post-contrast, multi-phase scans (arterial, portal venous, and equilibrium phases) compared to routine, 1.5 Tesla images acquired using a torso phased array coil.

Methods

We modified the product 3D fast GRE pulse sequence (General Electric Medical Systems, Waukesha, WI; software release 8.5M38) to allow variable-rate application of spatial saturation (SpSat) and/or chemical saturation (ChemSat). This allowed efficient data acquisition within a breath-hold (20-25 seconds). Different rates of SpSat/ChemSat were applied in healthy volunteers to determine the minimum value needed to adequately saturate signal from blood flow and fat. We acquire a full echo in the readout direction, with the slice partition as the inner loop and the phase-encode as the outer loop (both sequential); the saturation pulses were applied identically to each phase-encode within the inner loop. Interpolation was used in the slice-encode direction.

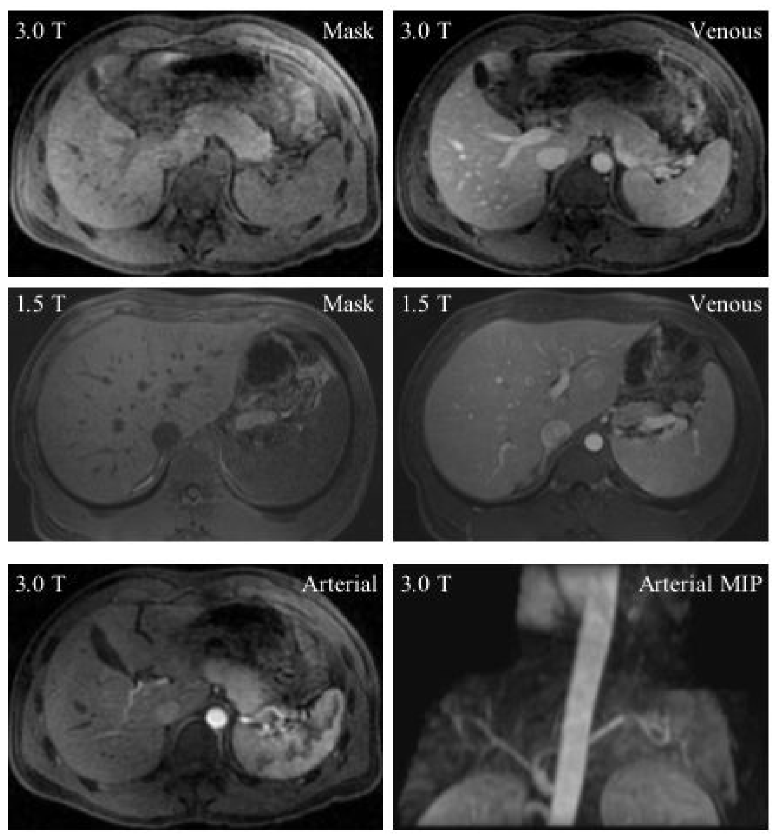
We scanned the abdomen in ten volunteers without contrast and one volunteer with contrast with the modified 3D GRE sequence using the following parameters: body coil, axial orientation, minimum allowed TE (1.3-2.0 ms), minimum allowed TR (3.8-5.0 ms), 11^{o} flip angle, 40x30 cm^2 FOV, 160x160 in-plane acquisition (reconstructed to 256x256), 40 slices per slab, 4.0 mm slice thickness interpolated to 2.0 mm, ChemSat and SpSat (inferior and superior), both applied once per slice partition loop. Four sequential phases (pre-contrast/mask, and three post-contrast phases, *i.e.*, arterial, portal venous, and equilibrium) were obtained.

Results

The 3.0 Tesla, body coil images without contrast (Mask) are comparable to 1.5 Tesla torso phased array images. There is excellent blood flow and fat saturation. Due to the changes in relaxation times [4], the 3.0 Tesla liver-spleen contrast ratio is less than that at 1.5 Tesla. But, this acquisition typically serves as a mask and is not likely to be the only T1-weighted sequence. Minimal artifact is seen with subtle “shading” across the liver, but this does not significantly degrade image quality or anatomic detail.

The post-contrast portal venous (Venous) image quality at 3.0 Tesla is better than expected. The vessels are clearly visualized, and like the 1.5 Tesla image, we observe the expected homogeneous enhancement of the liver. No significant shading or geometric, artifacts are apparent, and the anatomical detail (*e.g.*, margins of the pancreas) is well seen.

The 3.0 Tesla arterial phase (Arterial) image clearly depicts the right branch of the hepatic artery, thereby demonstrating that small structures can be resolved. Finally, the body coil 3.0 Tesla arterial maximum intensity projection (MIP) image shows the branches of the celiac axis.



Conclusions

We have demonstrated that rapid, 3D, fat suppressed, contrast-enhanced imaging of the abdomen using a body coil is not only feasible at 3.0 Tesla, but offers clinically acceptable image quality comparable to 1.5 Tesla torso phased array images. We obtained good anatomic coverage and high resolution. This sequence not only provides anatomic information including temporal contrast enhancement characteristics of lesions, but it can also be used for multi-planar reformations and MIP projections required for MRA exams.

References

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