Human Cardiac MRI at 3 Tesla Using a Whole Body Radio Frequency Coil

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Introduction

Concern over non-uniform signal intensity due to the attenuation and distortion of the excitation (B1) field by dielectric and conductive effects at high field strengths (1,2) has hampered the development of high-field human cardiac applications. Nearly all existing 3T and higher field strength scanners have been installed without a body RF coil. This has necessitated most high-field human cardiac studies to be performed using surface coils, which may have highly inhomogeneous field patterns for spin excitation. We report on the evaluation of a prototype whole body radio frequency (RF) coil for MR imaging in a 3T scanner. We have acquired cardiac images using the prototype body RF coil for both excitation and reception to demonstrate the signal uniformity across the heart using the high flip angle RF pulses of a black blood fast spin echo (FSE) pulse sequence (3).

Methods

A quadrature high-pass whole body birdcage coil was designed and fabricated at the General Electric Corporate Research Center in Schenectady, NY. The coil was 56 cm in diameter and 50 cm long. All scans were performed on a General Electric (Milwaukee, WI) 3T whole body scanner. A 45-year old normal male subject was placed in the scanner head first and supine. Oblique (short-axis) black-blood images were acquired using an FSE sequence with a double inversion recovery sequence for blood suppression (3). The acquisition matrix was 256 x 192 with a field-of view of 40 cm x 40 cm and a 5 mm slice thickness. The echo train length was 24 with an effective TE of 43.5 ms. Peripheral gating was used with the trigger occurring on every second heart beat, resulting in a TR of 1290 ms.

Results

Figure 1 is a short-axis, black-blood image of a normal volunteer acquired using the 3T-body coil for excitation and reception. Anatomical structures are well defined across the entire slice. The white vertical line through the heart indicates a cross section where a signal intensity plot was obtained. The signal intensity along the line that was drawn in figure 1 is plotted in Figure 2. The signal intensity of myocardial tissue (posterior wall, septum and anterior wall) is well above that of the blood (LV and RV) in all areas, indicating consistent contrast across the entire heart.

Discussion

The images acquired using the 3T-body coil show excellent signal uniformity and blood suppression. The higher signal intensity at the posterior wall of the myocardium may be due to dielectric effects. Surface receive coils may have the effect of balancing this variation since they have higher sensitivity near the body surface. The higher SNR afforded by the use of 3T whole body scanners may facilitate further improvements in cardiac MRI by allowing small structures such as valve leaflets to be delineated with higher resolution. Also, the higher SNR could be traded off for higher temporal resolution to improve applications such as coronary artery imaging. With the uniform signal intensity and suppression capabilities of the 3T body coil demonstrated in this work, imaging at 3T holds promise for rapidly advancing cardiac MRI. Additionally, since the body coil deposits power into a larger volume and in a more uniform way than a surface coil the power deposited per unit of tissue (specific absorption rate or SAR) will be lower.

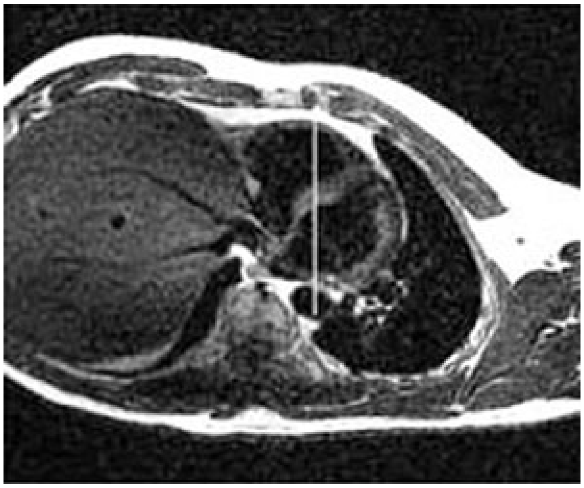

Figure 1

A black-blood short axis image of a normal volunteer acquired using a double-inversion recovery FSE pulse sequence and the 3T body coil.

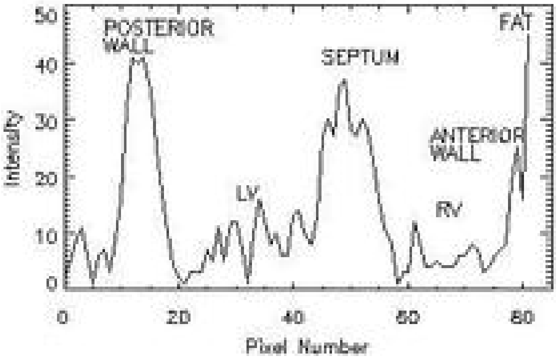

Figure 2

A signal intensity plot along the vertical line through the heart in Figure 1. The signal intensity and myocardium-to-blood contrast remains high to the posterior wall.

References

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