# Preliminary Experience with whole body MRI @ 7T

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**Introduction:**

High-field MRI at 7-Tesla inherently offers high SNR and enhanced soft tissue contrasts when compared to 1.5T or even 3T MRI, which might improve image quality in selected imaging applications in humans. However, the reduced Larmor wavelength in tissue (~12 cm), being shorter than the dimensions of the human body, renders non-neuro body imaging applications at 7T difficult [1]. The reduced wavelength causes B1-inhomogeneities that can lead to destructive B1-interference (signal voids). Moreover, the maximum applicable specific absorption rate (SAR) often constrains the choice of imaging sequence parameters. The purpose of this study was the initial exploration of 7-Tesla MRI of the thoraco-abdominal region in humans to investigate the potential benefits and limitations of high-field whole-body MRI in non-neuro imaging applications.

**Methods and Materials:**

All examinations were performed on a 7-Tesla whole-body MRI system (Magnetom 7T, Siemens Medical Solutions, Erlangen, Germany) equipped with a gradient system capable of 45 mT/m maximum amplitude and a slew rate of 220 mT/m/ms. A 34 cm inner-diameter circularly-polarized (CP) transmit/receive RF coil, length 38 cm (Siemens Medical Solutions, Erlangen, Germany) – not originally conceived for whole-body imaging applications - was used for RF signal transmission and reception. Four healthy volunteers (3 male, 1 female) were selected to fit within the spatial constraints of the RF coil. The subjects were placed head-first supine with the chest or abdomen in the sensitive region of the coil (Fig. 1) and inside the isocenter of the magnet. The imaging protocol encompassed 2D and 3D gradient and spin echo sequences for imaging of the liver, kidneys, spine, and heart. All scans were performed within breath holds of up to 30 seconds. High-field cardiac MRI was synchronized using peripheral pulse triggering. Cine-TrueFISP and cine-FLASH sequences were acquired along standard cardiac views (short and long axis, 4-chamber, 2-chamber, LVOT).

Fig. 1: Positioning of a healthy volunteer head-first supine with the abdominal region inside the CP transmit/receive RF coil.

**Results:**

All four subjects tolerated the examination time of 45 to 90 min and the relatively uncomfortable positioning on the table including the coil placement well. The imaging volume within the sensitive region of the CP RF transmit/receive coil was sufficient for imaging of the thoraco-abdominal region of the volunteers (Fig. 2). The coil qualitatively provided relatively homogeneous B1 signal over the sensitive volume of the imaging coil. The center region in most images, however, showed destructive interference with associated signal voids (Fig. 2). Due to SAR limitations in all body imaging applications, the excitation flip angle had to be reduced, resulting in reduced soft tissue contrast. Cardiac MRI with TrueFISP sequences in the tested setup was severely degraded by dark banding artifacts and the resulting signal inhomogeneities, especially at the heart/lung tissue interface. The cine-FLASH images showed good signal homogeneity over the cardiac volume. Myocardium-to-blood contrast, however, was reduced due to SAR flip angle limitations.

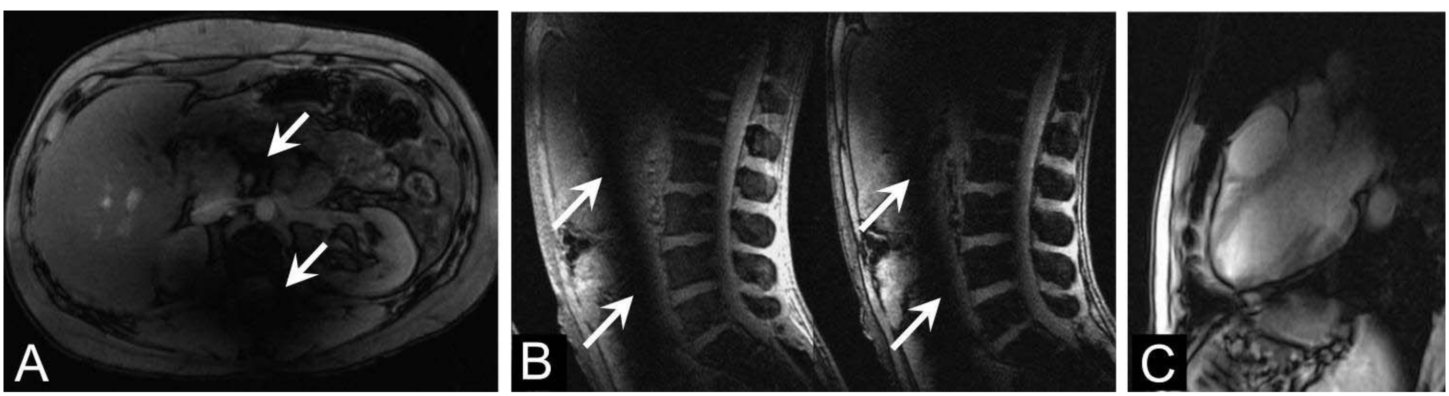


Fig. 2: (A) FLASH image of the liver; (B) In- and opposed-phase images of the spine. Arrows mark B1 signal voids. (C) Cine-FLASH image of the heart showing good signal homogeneity. Note: The myocardium-to-blood contrast here is limited due to a reduced excitation flip angle.

**Discussion:**

These initial results demonstrate that whole-body MRI at 7T is promising even with use of a transmit/receive coil not intended for this purpose and without B1 shimming or transmit sense approaches, but also clearly shows the limitations of this approach to high-field body imaging. Due to the size and design of the coil, only selected volunteers are eligible to be examined with this coil. Furthermore, this coil does not allow parallel imaging, which would be very useful for breathhold scanning with higher resolution. Using the coil as transmit only in combination with surface receive coils could circumvent this problem, but the space inside the coil is already limited. Nevertheless, the coil provides an excellent opportunity to explore the potential of high magnetic field for selected body applications and perform initial work on image parameter optimization.

**References:** [1] DelaBarre et al.; ISMRM 2007, p. 3867