A flexible 8-channel transmit/receive body coil for 7 T human imaging

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Introduction

Symmetrically excited meander elements have been shown to be superior to common strip line elements for 7 T imaging [1]. In particular, due to their higher intrinsic decoupling in coil arrays and the larger penetration depth inside the sample, a higher signal-to-noise ratio can be obtained by such elements. Standard strip-line elements have been previously utilized in body imaging arrays [2]. The purpose of this work was to investigate strip-line elements with meanders for use in flexible body arrays at 7 T.

Materials and Methods

The body coil consists of two arrays with 4 elements (length 25 cm) each (Fig. 1), which are placed dorsally and ventrally on the human body. The elements of the dorsal array are arranged in a plane on a sliding frame inside a PMMA housing. The sliding frame is used to position the array relative to the patient along the longitudinal axis. Including a thin cushion, the distance from the elements to the body surface is 25 mm. The elements of the ventral array are enclosed in individual modules made of Macrolon. The modules are interconnected with a Neoprene sheet making the ventral array flexible so that it can be accommodated to the patient's contour (Fig. 1). The distance between the elements and the body is 30 mm, as determined by the module dimensions. SAR calculations were performed in a male human body model derived from the Visible Human Project using FDTD simulations (Empire XCcel, IMST, Germany). The coil was driven in a geometrical CP mode [2] with the excitation phases of the elements corresponding to their azimuthal angle with respect to the center of the body. Imaging experiments were performed in 3 subjects on a 7T whole-body MR system (Magnetom 7T, Siemens, Erlangen).

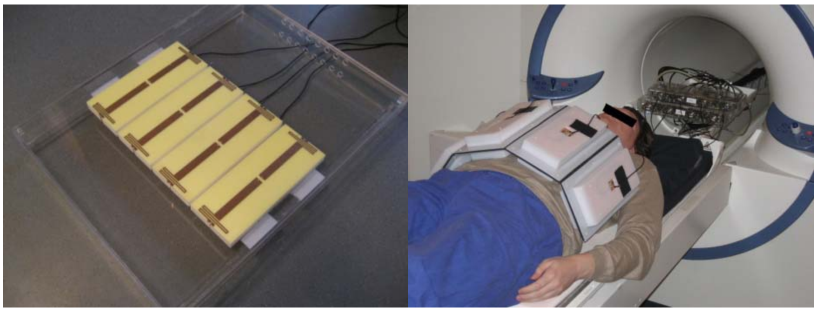

Figure 1: Dorsal array (left) and ventral array positioned on volunteer (right)

Results

The coupling between the array elements is below -20 dB. Thus, the use of decoupling capacitors is unnecessary. The reflection coefficients of the elements are below -15 dB. Both coupling and matching are independent of the patient's size since the distance from the elements to the body surface is constant. SAR calculations show that 100 W (rms) can be applied to the body array in geometrical CP mode without exceeding the limits for localized 10g-averaged or partial-body SAR. Because of the flexibility of the ventral array, which keeps the radius of curvature of the array comparable to the radius of curvature of a large head coil, the $B1^+$ uniformity is still tolerable even in large volunteers. Fig. 2 shows a reasonably homogeneous T1-weighted flash image of a volunteer of 100 kg body mass. The acceptable $B1^+$ uniformity in conjunction with the high SAR efficiency allows for spin-echo imaging as shown in Fig. 3. Further, due to the excellent SNR and parallel imaging capability, the flexible body array was successfully applied for cardiac imaging (Fig. 4). The effective field of view extends 20 cm in the z-direction.

Discussion

The presented results show that that image homogeneity is already good for 7 T body imaging, but further improvements are expected using RF shimming [2] or Transmit SENSE [3]. Since the array has 8 transmit/receive channels, both receive acceleration, as shown here, and parallel excitation (Transmit SENSE) are possible. Since the SAR efficiency is high, spin-echo imaging is possible.

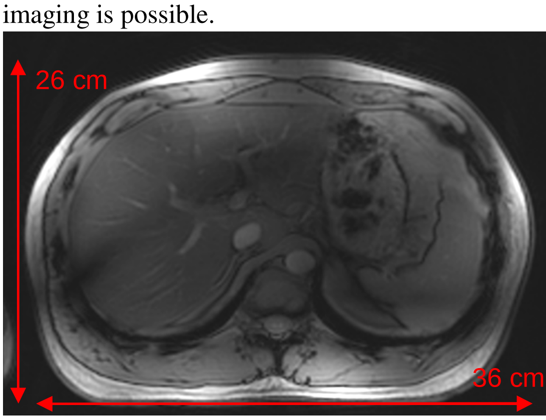

Figure 2: T1-weighted FLASH image, in phase, breath hold. Volunteer: 1.86 m, 101 kg.

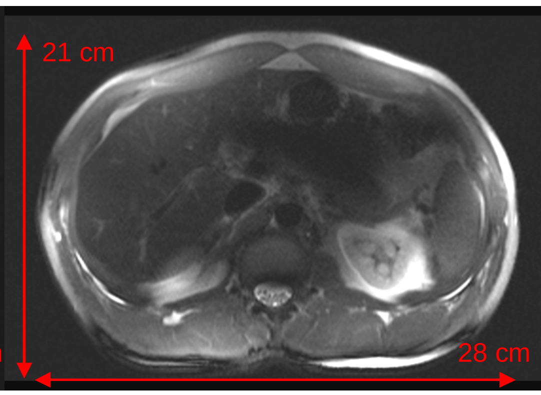

Figure 3: T2-weighted HASTE image, breath hold. 15 slices were acquired simultaneously at a refocusing angle of 150°. Volunteer: 1.73 m, 69 kg

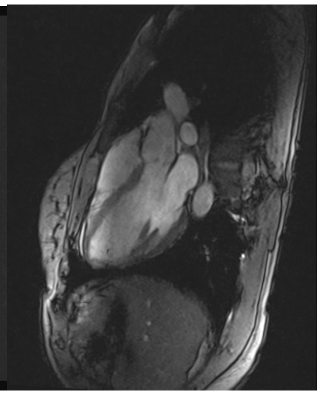

Figure 4: FLASH 2D, GRAPPA R=2, retro-triggered LVOT, breath hold. Volunteer: 1.65 m, 60 kg.

[1] S. Orzada et al.. Proc. Intl. Soc. MRM 16 (2008), 2979 ; [2] G. J. Metzger et al. MRM 59: 396-409 (2008); [3] U. Katscher et al. MRM 49:144-150 (2003)