Separate Transmit and Receive Arrays for 7T Body Imaging

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Introduction: It is known that using a large volume array in conjunction with local receiver arrays (1) increases spatial sensitivity and SNR when compared to either local transceivers or large volume coils (2,3). It has also been shown that volume arrays (are we talking transmit volume arrays) improve the B_1^+ homogeneity in the head over surface arrays (4) and it is believed that volume arrays reduce local SAR in the periphery when compared to surface arrays. To date most body imaging at 7T (5-7) has been restricted to surface transceiver arrays. We have designed an 8-channel transmit only TEM array to be used in conjunction with a 16 loop receiver array and B_1^+ shimming algorithm for body imaging at 7T.

Methods: All imaging experiments were performed on a 7T (ω_o=296.4 MHz), 90 cm bore magnet (Mangex Scientific, UK) equipped with Siemens console and whole body gradients. Eight 1 kW amplifiers (CPC, Brentwood(is it Hauppauge), NY) with independent phase and amplitude modulation capabilities were used for excitation.

The volume transmit array was an 8-channel TEM array (fig 1a). The physical geometry of the individual coil elements are 15.3 cm in length with 1.9 cm inner conductor and a 5.0 cm outer conductor. A 1.9 cm thick PTFE dielectric, with a low loss tangent and a permittivity of 2.08, separated the inner and outer conductor. PTFE plates were used to secure and house four coil elements—this provided a four-channel anterior and four-channel posterior array. A 5.0 cm air gap separated each coil element. Each element was individually tuned to the proton's resonant frequency at 7 tesla. Interconnecting capacitors were used to decouple nearest neighbor elements (> -18 dB isolation when loaded). Active PIN diode detuning was used to detune the volume array during reception. Local B_1 shimming was employed to optimize the transmit phase for each element on the array (8).

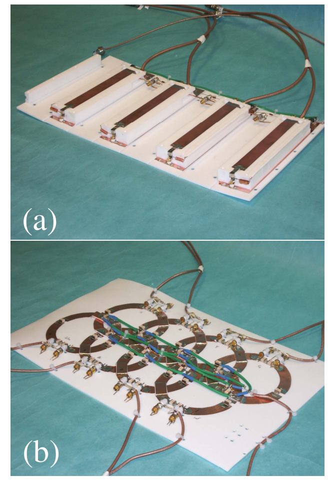

Figure 1: (a) the anterior plate of the TEM transmit only array and (b) the anterior plate of the loop receiver array.

The receivers consisted of two 8-channel loop arrays (fig 1b). Each loop in the array had an inner diameter of 7.62 cm and was constructed from 1.27 cm wide copper foil tape. Similar to the transmit arrays, an anterior and posterior array were constructed; each array had two rows with each row having four coil elements. Each element was individually tuned to proton's Larmor frequency at 7T. Elements were decoupled from other neighboring coils via geometric positioning (less than 5% average coupling between elements when loaded) and was actively detuned during transmit via PIN diodes.

The two arrays were designed such that the transmit-only array would be placed approximately 10 cm away from the patient's pelvis to increase peripheral B_1^+ homogeneity. In order to maintain high SNR, the receiver arrays were placed approximately 1 cm away from the patient (see fig. 2).

Results: Multi-slice gradient echo images were acquired over the male pelvis. Figure 2a shows the mid-sagittal slice (TR/TE=150/4.10 ms; FA=30º; resolution: 1.25 x 1.25 x 5.0mm) and an axial slice (TR/TE=50/5.12 ms; FA=30º; resolution: 1.75 x 1.75 x 5.0 mm). The yellow lines in figure 2a,b show the approximate placement of the receiver array while the light blue lines show the distance between the patient and the transmit array. Figure 2a,b show near complete volume coverage of the male pelvis with relatively good homogeneity. The image intensity was corrected to reduce the exceptionally high signals in the direct proximity of the receiver arrays. Minor transmit RF inhomogeneities are still present but it is believed that improvements in global B_1^+ shimming algorithms will significantly repress these inhomogeneities..

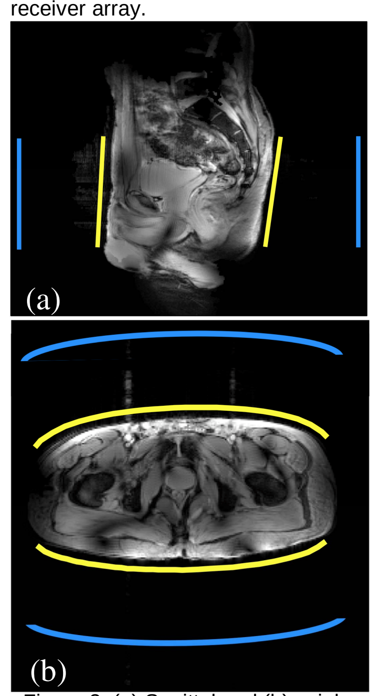

Figure 2: (a) Sagittal and (b) axial images of the male pelvis. The blue lines show the relative placement of the transmit array while the yellow lines show the relative placement of the receiver.

Conclusions: A new transmit-only receive-only array design has been presented for body imaging at 7T. Using this combination of arrays, in conjunction with a B_1^+ shimming algorithm has been shown to provide highly homogeneous coverage over a localized region of the body.

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