A Six-Element Tranceive Surface Coil Array for Prostate MRI at 4.0 Tesla

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Introduction:
Magnetic Resonance Imaging of the prostate requires specialized radiofrequency (RF) coils to maximize the signal to noise ratio (SNR) deep in the region of the prostate. Endorectal RF probes are commonly used to improve SNR by their proximity to the region of interest. To reduce patient discomfort, it is desirable to eliminate the need for endorectal probes by designing external RF coils, while still maximizing SNR in the prostate. A six-element, external tranceive surface coil array is demonstrated for imaging and spectroscopy at 4.0 Tesla. This coil provides high SNR throughout the pelvis, and maximum patient comfort. To maintain RF homogeneity throughout the pelvis, a corporate feed network was designed to generate an appropriate phase relationship between each of the coil elements. The purpose of this work is to discuss the implementation of such a coil, to evaluate its performance and to outline its medical imaging applications.

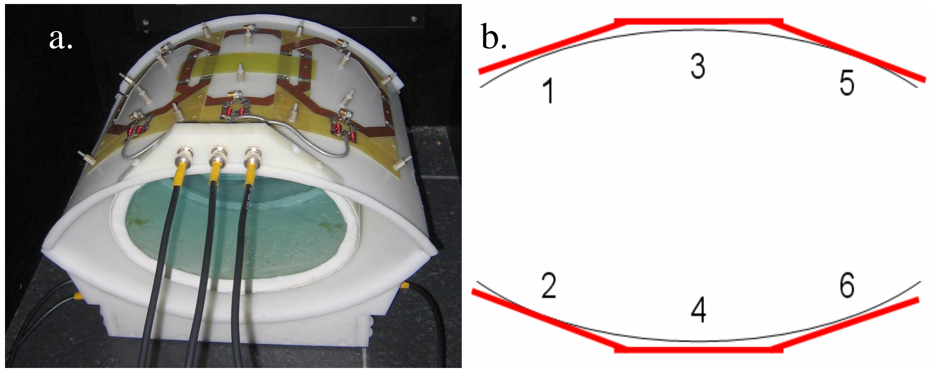

Figure 1. a) Six-element external tranceive surface coil array for pelvic imaging. b) Schematic showing the orientation and the numbering of the elements.

Methods:
The coil is shown in Figure 1. Two curved panels – one anterior and one posterior – are formed from heat-formable plastic (Rolyan®). Three identical coil elements (16 x 18 cm) are mounted on each of the panels and the nearest neighbour elements are decoupled using the overlap method [1]. All coil elements are tuned and matched using the parallel to series capacitance ratio method [2] and balanced with quarter wavelength lattice baluns [3]. The RF front-end of our 4T Varian MRI system consists of a 7kW, single channel RF amplifier, and 4 independent receiver channels. The feed network is designed to enable compatibility between this system and the six-element coil. Figure 2 shows how the feed network incorporates a 3-way high-power splitter, 3 hybrid 180° couplers, and 2 TR switches to supply current to each of the coil elements with the desired phase configuration. The phase driving scheme used is based on experimental findings of Pinkerton et al [4] for phased array pelvic imaging at 4T. The elements along the anterior panel have relative phases of 0°-180°-0° while the elements along the posterior panel have relative phases of 180°-0°-180°. T1-weighted images were obtained from a healthy volunteer using a FLASH imaging sequence (TR/TE=11/4ms, α= 11°). Phased array reconstruction was performed using the non-weighted sum of squares method.

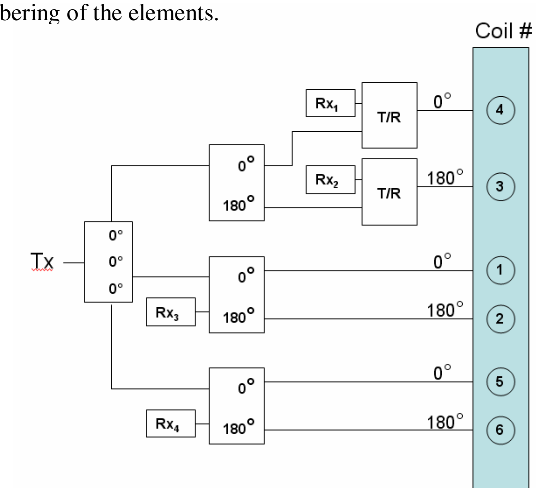

Figure 2. Layout of the corporate feed network and the driving scheme used. Refer to Fig 1 for element labels.

Results:
The feed network distributes the high-power RF signal to each of the coil elements with the desired phase configuration. Each of the coil elements is well isolated from its neighbours (>15dB). Figure 3 shows a representative image of a healthy volunteer using the pelvic array. The prostate is clearly visible at the centre of the field of view. The chosen driving scheme produces relatively uniform signal intensity throughout the region of interest.

Conclusion:
An external, six-element transceive surface coil array has been build for prostate imaging at 4.0 Tesla. A feed network has been designed and built to relate the coil to the RF front end of the imaging system with an appropriate driving scheme. This design yields images with high SNR throughout the pelvis without the use of an endorectal coil, thus improving patient comfort.

Figure 3. Axial FLASH image of male pelvis. Prostate is clearly visible at centre of torso.

References:
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[4] Pinkerton et al. Proc Intl Soc Magn Reson Med, Abstract #2588, 2006.

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