

Four Element Endorectal Array Coil for Improved Sensitivity in Human Prostate Imaging

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Introduction: Prostate cancer is the second most common cause of cancer death in men. (1) Studies suggest endorectal MRI is useful for predicting local extension; tumor site and tumor size of cancer foci greater than 1 cm. (2) Other studies have suggested that MRI studies have limited clinical usefulness. (3) The goal of this work is to increase sensitivity in endorectal MRI of human prostate. We propose a design for an endorectal coil designed as a four channel multi coil array to improve sensitivity.

Methods and Materials: We have designed built and tested a 4 element multi coil phased array (4) in an endorectal coil housing for use on a 3 Tesla MRI System (GE Discovery 750). (Figure 1) Each of the four elements on the order of 1 square inch in area are overlapped to reduce mutual inductance, each coil having an active transmit block circuit and connected to system with one full wavelength length of coaxial cable. Because the array is linear in one direction, tying the shield of each coax together across the mid plane of the array obviates the need for baluns or cable traps to break shield loops since none exist. Although smaller loop elements will have a higher fraction of coil noise to sample noise, smaller coils also are exposed to less sample noise and can produce high signal to noise ratio in the very near field. A schematic of 1 element is shown in Figure 2 and all 4 are similar.

Figure 1

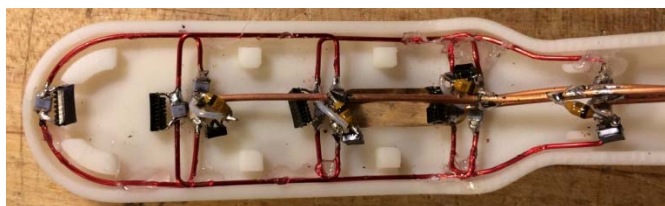
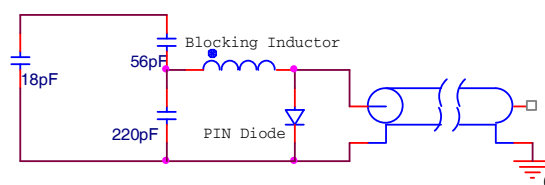


Figure 2



System Setup and Image Acquisition: The array coil is connected to a research coil adapter coil adapter containing 4 low noise preamps and protection circuits. Images were acquired with a GE FSE-XL sequence with the following parameters: TR 3000ms, TE 68ms, 0.6mm slice thickness, FOV 8cm, ETL 24, BW 12 KHz, and scan time 1:12.

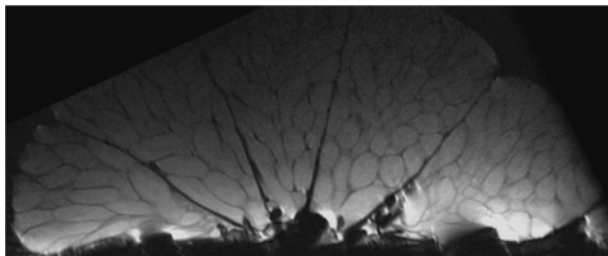


Figure 3

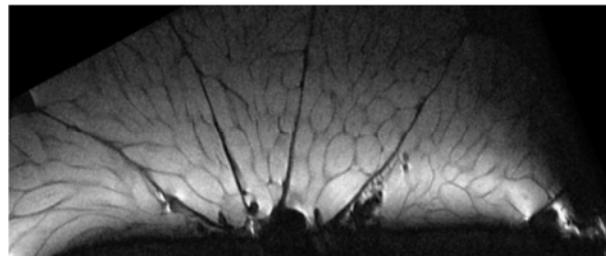


Figure 4

Results: With a 0.6mm slice thickness and 0.156mm in plane resolution, Figure 3 shows the image from the four channel linear array and figure 4 shows the image from a single coil the same size as the array. Close analysis shows a factor of 2 increases in SNR up close to the array and a factor of 1.2 increase of SNR at 3cm depth.

Conclusions and future direction: We have demonstrated a significant improvement in image quality of Endorectal MRI imaging with the use of multi coil arrays. This could be useful in very high resolution imaging of positive biopsy patient to assess whether the cancer is extra capsular. Since a large fraction of cancers are proximal to the rectal wall the increased sensitivity could be important, especially for high b-value diffusion weighted imaging. Improvements in sensitivity could come from putting active preamplifiers inside the probe and by susceptibility matching the air cavity inside the array with diamagnetic materials.

References:

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- (4) The NMR Phased Array Roemer ET. al. MRM V16, Issue 2, pages 192–225, November 1990