

Wireless phased array endorectal coil for prostate imaging

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Introduction: Prostate cancer is the most common malignant tumor in men and the second leading cause of cancer deaths in men. Due to the superior soft tissue delineation MRI is the modality of choice especially for imaging the prostate. It is widely known that for exceptional imaging of the prostate gland, the most commonly use technique is a combination of a torso (body) phased-array and the endorectal coil [1][2]. However such a set up present system challenges, in order to incorporate the cabled connections between the torso phased array and the cabled endorectal coil and the way that the system will combine the signal from both coils appropriately in order no imaging artifacts to appear. In this paper, a wireless phased array endorectal coil is presented that can be remotely positioned on the targeted region of interest and, can inductively coupled to RF body coil or to an external torso phased array coil for imaging the prostate gland. The proposed wireless coil design has no cables and no cable baluns, no pre-amplifiers or active elements (active detuning circuits). The absence of such components leads to a reduction in weight and bulkiness of the coils without sacrificing image quality and SNR. Additionally, the wireless coils can operate with any OEM MR system at the particular field of interest. SNR measurements of the wireless endorectal coil in combination with an 8 channel external torso phased array coil indicate that the increase in SNR in the prostate area with the wireless prostate coil is 7.5 times in average when compared with the SNR of the torso array only, In addition, in vitro imaging of a structure object (pineapple) was performed at 1.5 T and compared favorably when compared with a cabled endorectal coil in terms of SNR and coverage. .

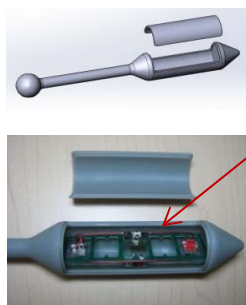


Fig. 1

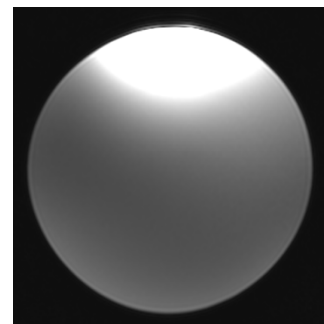


Fig. 2

Methods: As a proof of concept a representative configuration of the inductive wireless phased array endorectal coil is shown in Fig.1. The dimensions of coil elements are 6.5 X 2.2 cm each. The coil was constructed using 18 Gauge copper wire on FR4 laminate. The elements were tuned to 63.65 MHz and 123.2MHz, respectively. Both coil elements are passively decoupled from the RF body coil during the transmit phase. Bench tests were conducted on the wireless prototype coil and the measured Q ratio of unloaded to loaded Q is 320/90=3.5 at 123.2 MHz and 420/110=3.8 at 63.65 MHz, while the isolation between element of the phased array is better than -15dB when the coils are unloaded.

Results: SNR measurements performed on a Siemens Verio 3.0 T magnet using a standard GRE sequence (TR/TE=300/10ms, FOV=20cm, Slice=3mm, Matrix256x256) on a 1900 mL phantom consisting of NiSO₄ X6H₂O+ 5g NaCl under two configurations. The first measurement combined both the wireless endorectal coil with an 8ch torso phased flex array coil shown in Fig.2, while the second configuration included 8ch phased torso flex array coil only. Fig.3 shows the measured SNR profile of the combination between the wireless endorectal coil and the 8 channel phased array coil. The SNR of the 8 channel Torso array only on the phantom was measured to be 250 in average. As the table 1 indicates, the presence of the wireless endorectal coil enhances the SNR in the region of interest by 7.5 fold in average. Furthermore, Fig. 4 shows a T1 weighted (TR/TE=550/9.7ms, FOV=23cm, Slice=5mm, Matrix512x512) and T2 weighted (TR/TE=4540/102ms, FOV=22cm, Slice=5mm, Matrix384x512) imaging of a pineapple with the wireless endorectal coil and external phased array coil combination. .

Conclusions and Discussion: A novel wireless endorectal phased array coil design was presented. It has shown that this coil can greatly improve image quality in terms of SNR and signal penetration on the prostate gland by 7.5 fold in average with the combination of both wireless endorectal coil and 8 channel flex phased array coil. When compared with an external cabled 8 channel flex phased array coil only. In addition to the SNR improvements, the wireless phased array endorectal coil design is lightweight, enhances patient comfort and set up workflow and can be made to be a disposable device. Besides the significant improvement in SNR, the proposed phased array design of the coil provides significant coverage over the prostate gland.

References:

1. Beyersdorff D, Taymoorian K, Knösel T, Schnorr D, Felix R, Hamm B, Bruhn H. MRI of prostate cancer at 1.5 and 3.0 T: comparison of image quality in tumor detection and staging. AJR Am J Roentgenol. 2005 Nov; 185(5):1214-20.
2. Yiğitcan Eryaman, Yusuf Öner, Ergin Atalar. Design of internal MRI coils using ultimate intrinsic SNR Magn Reson Mater Phy (2009) 22:221-228

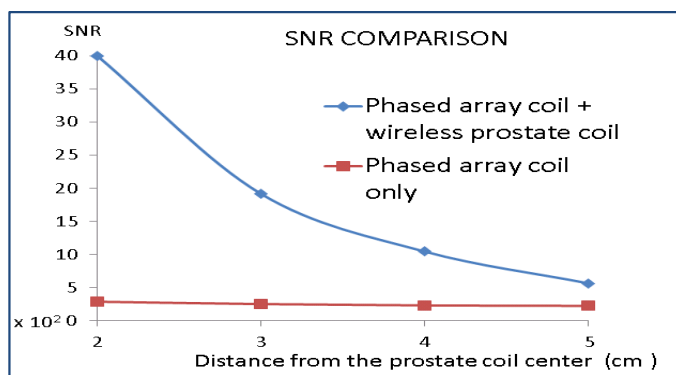


Fig. 3

Distance from the endorectal coil	SNR	
	Endorectal coil & array coil	Array coil only
2 cm	4000	289
3 cm	1917	253
4 cm	1046	233
5 cm	566	226

Table 1

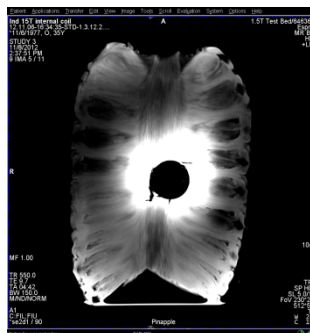


Fig. 4a T1 image of pineapple with endorectal and phased array coil

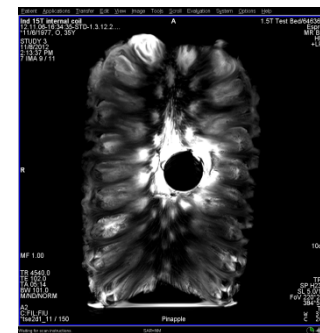


Fig. 4b T2 image of pineapple with endorectal and phased array coil

Fig. 4