# Signal characterization of a novel two-channel rigid endorectal coil for MR imaging of the prostate

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## INTRODUCTION:

MR imaging of the human prostate is widely used as a clinical tool for the diagnosis of prostate cancer [1], primarily because of vastly improved soft tissue contrast when compared to other imaging modalities (i.e. CT, Ultrasound). Endorectal surface coils are often used to increase the signal to noise ratio (SNR) over the entire prostate[2]. The increased SNR benefits many sophisticated imaging modalities, including diffusion weighted imaging, dynamic contrast-enhanced imaging, and spectroscopic imaging. Recently, a novel, dual-channel, rigid endorectal coil has become available (Sentinelle Medical Inc.,Toronto, Canada) : it is smaller than current coils, reusable, and provides a improved SNR over a larger volume of interest, especially in the peripheral zone where roughly 80% of prostate cancers are found [3]. We present a preliminary comparison of this new rigid coil with that of a widely used disposable, inflatable endorectal coil (Medrad Inc., Warrendale, USA).

## METHODS;

All experiments were performed on a 1.5T General Electric Signa HD MRI scanner equipped with “echo speed” gradients and a cylindrical phantom possessing an interchangeable hollow inner cylinder for coil insertion. The phantom’s content was a 90mM creatine solution doped with sodium chloride (3.6%) to provide adequate coil loading, and cupric sulphate (8 mM) to reduce relaxation times. The inflatable coil was filled with perfluorocarbons rather than air to reduce magnetic susceptibility artefacts[4]. Three sets of experiments were performed for both the inflatable coil and the new rigid coil. Firstly, a set of axial and sagittal T2 weighted FSE image data sets were acquired with a matrix of 256 x 256, TE/TR = 112/5500ms, slice thickness = 2mm, spacing = 2mm, ETL = 16, and FOV = 30cm. Secondly, a single voxel spectroscopy experiment using the PRESS sequence was acquired with TE/TR = 50/1200ms, and 30 x 30 x 30mm voxel size placed 5 mm away from the coil-solution interface. Lastly, two sets of MRSI data were acquired with a 16 x 8 x 8 matrix, TE/TR = 50ms/1200ms, and voxel sizes of 0.38 mL, and 0.16 mL. SNR calculations for both imaging and spectroscopic data were performed using in-house software tools.

## RESULTS:

In both the imaging and spectroscopy data sets we observed a dramatic improvement in SNR over the entire imaging space using the new rigid coil. In regions closest to the coil, we observed a ~5-fold improvement in SNR, as compared to the inflatable coil. In Figure 1A, we present the SNR plots for the axial imaging plane using both coils. In figure 1B, the normalised SNR is plotted as a function of depth on the anterior side of the coils. Over a 15 mm distance from the coil edge we observed a SNR improvement ranging from ~1.5 to 5 times that of the inflatable coil, with an average SNR improvement of ~200% over a 30 mm cubic volume positioned 5mm above the coil. Single voxel spectroscopic results, as seen in figure 1C, demonstrate a ~200% improvement in SNR over a large voxel of approximately the same size and position as the prostate. MRSI produced similar results showing improved SNR in voxels corresponding to the locations of the “peripheral zone” and “central zone” of the prostate.

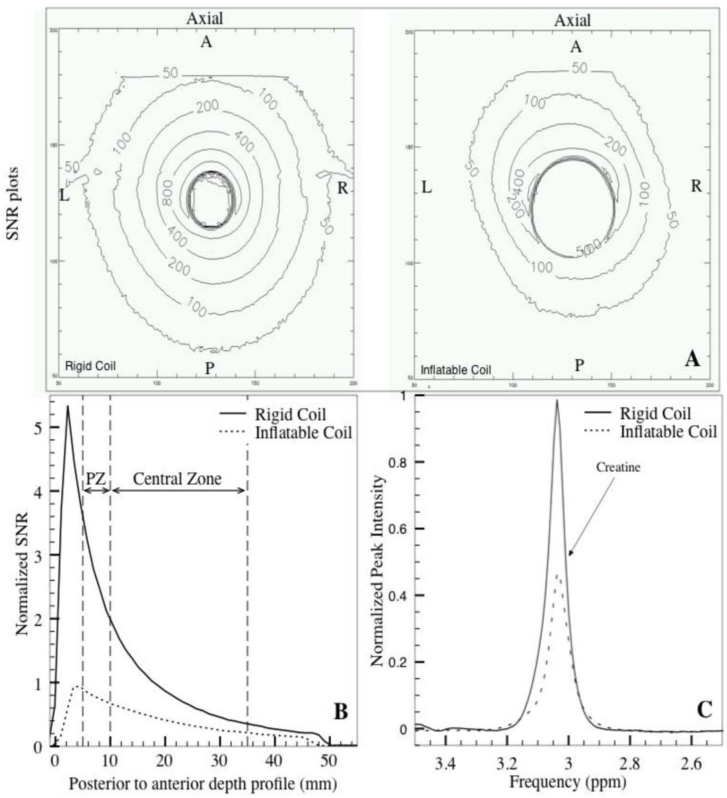


**Figure 1**: (A) A comparison of the rigid coil with the inflatable coil showing SNR as a function of distance in all 3 imaging planes. The bright red regions indicate a more intense signal, while the decaying shades of blue represent decay of the signal In (B), the normalized SNR versus depth is plotted for both coils. In (C), spectra of creatine obtained from a single voxel experiment demonstrate a ~200% improvement in SNR with the rigid versus the inflatable coil.

## DISCUSSION AND CONCLUSION:

Better spatial coverage and an incredible improvement in SNR were obtained for both MR and MRSI using the newly designed dual-channel rigid coil. As shown in figure 1A in the axial column, we observed a fairly uniform signal profile in the right/left direction. In the sagittal plane we observed a longer sensitive region over which the SNR is increased when compared to the inflatable coil. Over the spectroscopic volume of interest(VOI), in both single voxel and MRSI experiments, we observed excellent SNR in regions corresponding to the peripheral zone and the central zone.This is clinically beneficial since 80% of prostate cancers lie in the peripheral zone. The observed ~5-fold improvement in signal drops off nearly exponentially when moving anteriorly from the peripheral zone into the central zone. This effect averages the SNR improvement over the entire region of interest, as observed in figure 1C where we observe a ~200% improvement in SNR for the single voxel MRS experiment. Currently, there have been limited reports on the use of rigid endorectal coils in MR imaging of prostate [5, 6] outlining the advantages of using a rigid coil. Noworolwski *et al* [5] recently demonstrated similar results with improved SNR using a single channel design. In comparison, the rigid coil presented here has a higher SNR in the peripheral zone. With the significant improvement in SNR, it may be possible to reduce voxel-size- and improve resolution for spectroscopic imaging. Additionally, the small coil does not significantly distort the prostate, making it easier to perform inter-modality image registration for treatment planning purposes (i.e. MR/CT or MR/Ultrasound image registration). In summary, we have presented a comparison of a standard inflatable coil with a novel dual-channel rigid coil that has vastly improved SNR for MR of the prostate, with the potential to greatly improve diagnosis of various prostate conditions.

**References:**

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