

Clinical comparison of SNR between a currently available and a new dual-channel endorectal receive coil for prostate imaging at 1.5 and 3T

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INTRODUCTION: Generally, the primary method to diagnose prostate cancer is a transrectal ultrasound guided biopsy after elevated prostate-specific antigen levels or a deviating digital rectal examination. Histopathology of the biopsy ultimately confirms the presence and Gleason Score (GS) of prostate cancer (1). After diagnosis, accurate staging and determination of extracapsular extension (ECE) is necessary to make an adequate choice of treatment. In both diagnosis as well as treatment management of prostate cancer, MRI is increasingly being used. The use of an endorectal coil (ERC) for prostate MRI increases the signal to noise ratio (SNR) compared to external coils, which leads to a better visualization of ECE and staging performance due to a better spatial resolution (2-4). After almost a decade of using a single loop ERC at 3T, a new ERC concept is introduced for use at 3 and 1.5T. In this study, we compare the SNR of the currently used single-loop ERC to an investigational next generation two-channel endorectal coil (NGE, Medrad®) with the ability of parallel imaging techniques (iPat) for a shorter acquisition time, at both 1.5 and 3T.

METHODS: The NGE coil was a disposable two channel receive only coil with 2 overlapping loops in left-right configuration (fig.1). The NGE coil was designed and evaluated to be fully decoupled from the body transmit coil, even if it was not connected to the interface, or without interface – table plug connection. The size of the NGE balloon was slightly larger than the current single loop coil, but the softer latex and thinner coil wiring made the balloon more flexible and easier to insert. Eight consecutive patients who were scheduled for a staging MRI were included.

The study was approved by the institutional review board and informed consent was obtained from all patients. Four patients were scanned at 1.5T and four at 3T, in the supine position. Peristalsis was suppressed by intramuscular injection of 1 mg Glucagon and 1 mg Buscopan, and an additional intravenous injection of 1 mg Buscopan. First, the NGE was inserted and filled with approximately 60mL of perfluorocarbon. The usual staging protocol was performed, consisting of T2-weighted images (T2w) with and without acceleration (iPat), diffusion weighted imaging (DWI) with and without iPat (fig. 2b,c,e,f) and MR spectroscopic imaging (MRSI). Second, in the same patient, the identical staging protocol (fig. 2a,d), now including dynamic contrast enhanced (DCE) imaging, was performed with the ERC, filled with approximately 45mL of perfluorocarbon. For both coils, next to a pre-contrast proton density (PD) image set with low flip angle and long TR, an identical image set without excitation pulse was made (PDP0) to obtain a corresponding image set with only noise. These images were chosen to quantify SNR in patients, because of the least T1/T2-weighting in PD-images and the fair noise values of the PDP0. At mid-prostate level the SNR-profiles for each field strength were calculated in every patient at the same anatomical location for both coils (red line in Fig 2g). The mean of all four patients per field strength together resulted in SNR-profiles of the NGE and ERC.

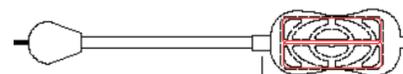


Fig. 1 NGE coil with two loops in red

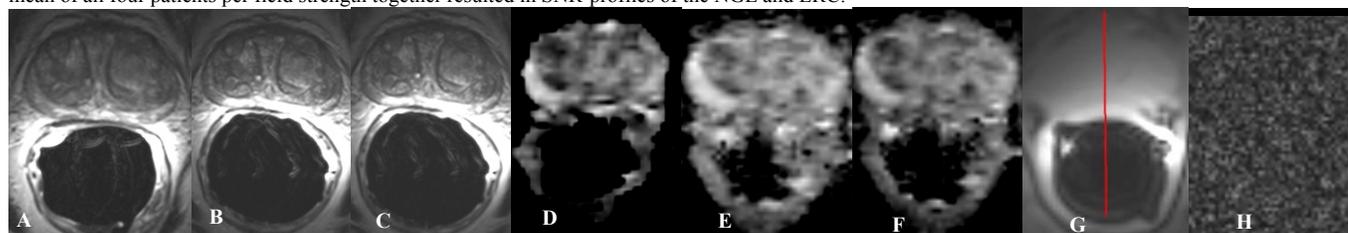


Fig. 2. Examples of both coil types and different sequences at 1.5T for the midprostate. A) T2w ERC, B) T2w NGE, C) T2w NGE-iPat, D) DWI ERC, E) DWI NGE, F) DWI NGE-iPat. G) PD image, with the red line representing the direction of the SNR-profile, H) PD only noise

RESULTS & DISCUSSION: At 1.5T the mean SNR of the NGE was higher than for the ERC up to a distance of approximately 57 mm from the coil (Fig. 3a). For this field strength, the mean (across 4 patients) maximum SNR value of the NGE coil had increased a factor of 2.9 compared to the ERC. At 3T the mean SNR of the NGE was higher than the SNR of the ERC up to a distance of approximately 40 mm from the coil (Fig. 3b), and the maximum value of SNR of the NGE was 3.4 times higher compared to the ERC. Acquisition times at 1.5T were 3m47s for T2w of both coils, and 2m57s for the iPat sequence of the NGE. At 3T the acquisition times were 4m13s for T2w of both coils and 3m13 for the iPat sequence of the NGE (combination of two-fold acceleration but 3 instead of 2 averages). All shorter acquisitions were of diagnostic quality. Thus, for an accurate assessment of staging or ECE in the dorsal part of the prostate, which consists generally of the peripheral zone (PZ), neurovascular bundles and seminal vessels, the NGE has a clear benefit compared to the ERC. However, for the visualization of the ventral part of very large prostates, the NGE will not give any benefit over the current ERC. With the possibilities for parallel imaging, the NGE coil produces images similar to the current ERC with respect to SNR with a shorter acquisition time.

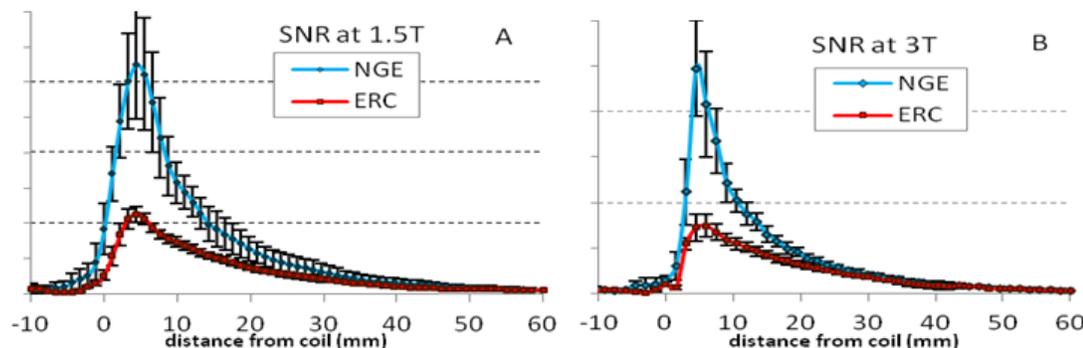


Fig. 3. Mean SNR-profiles with SD of NGE and ERC of a straight line in AP-direction in an axial slide through the midprostate of 4 patients, at a) 1.5T and b) 3T. The 0 value on the x-axis represents the dorsal part of the prostate closest to the coil, the positive numbers to the right represent the distance from the coil. Error bars are the standard deviations on the mean of 4 patients.

CONCLUSIONS: For staging and the assessment of ECE in the dorsal part of the prostate the NGE coil gives a benefit compared to the current ERC with respect to SNR. With the possibilities for parallel imaging, the NGE can provide current clinical protocols in a shorter acquisition time.

References: (1) Epstein J, Am J Surg Pathol 2005 (2) Fütterer JJ et al, Radiology, 2006 (3) Heijmink S et al, Radiology, 2007 (4) Fütterer JJ et al, Eur Radiol 2007

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