

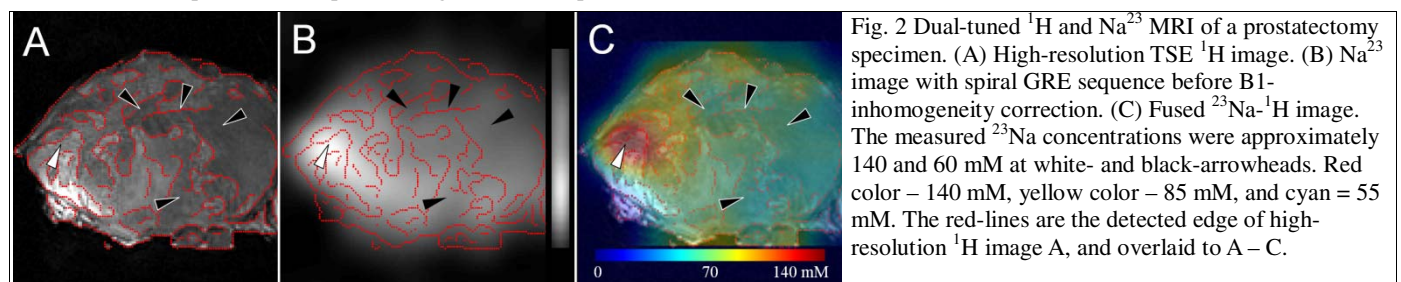
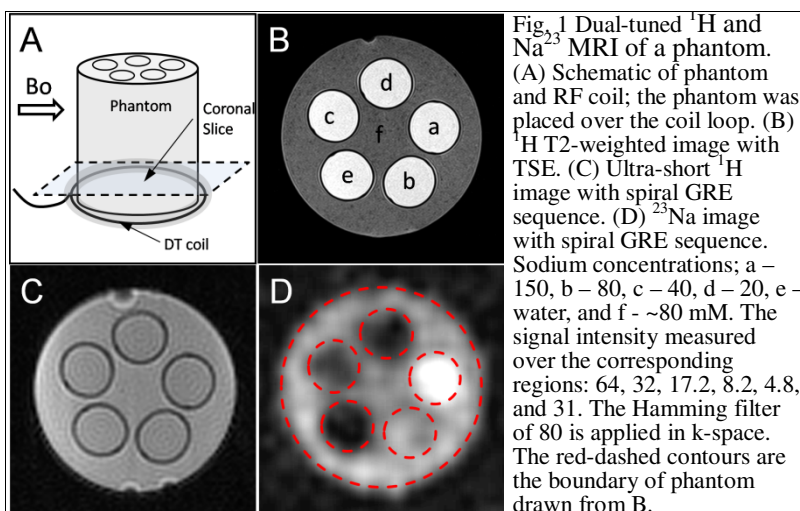
Proton and sodium MR imaging of prostate using a dual-tuned endorectal coil at 3 T

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[Introduction] Prostate cancer is the most commonly diagnosed malignancy and the second most common cause of cancer death of men in the United States [1]. In standard MRI, prostate cancer is typically characterized as a region of low T2 signal intensity in the normally high T2 peripheral zone. This finding is highly sensitive but not very specific. To improve the specificity, combining MRS and endorectal morphologic MR imaging have been advocated. MRS, however, is not widely used in daily clinical practice because it is technically demanding with image acquisition and interpretation. Sodium (Na^{23}) MRI also provides useful information that reflects the physiological and biochemical characteristics of normal and cancerous tissues [2]. Excised prostate specimen was found to show low Na^{23} concentrations in tumors [3]. While Na^{23} MRI may have the potential as an imaging tool to improve the detection and characterization of prostate cancer, it is highly desirable to be able to image both ^1H and Na^{23} MRI using a dual-tuned coil without switching coils. The dual-tuned imaging will maximize the benefits of acquiring both morphologic and functional information for accurate diagnosis of prostate cancer in a clinical setting. To achieve this objective, we have recently developed a dual-tuned endorectal coil (eCoil) [4]. Thus, the purpose of this study was to test the feasibility and performance of the dual-tuned ecoil imaging at 3T using a phantom and prostatectomy specimens from patients with prostate cancer.

[Materials and methods] All scans were performed on TimTrio 3T scanners (Siemens Medical Solutions, Erlangen, Germany) with the dual-tuned eCoil RF interface system (MedRad, PA, USA). The single-loop eCoil (diameter = 60 mm) was used. The phantom was constructed by molding and solidifying aqueous agarose solution of ~80 mM sodium concentration in a medical biopsy specimen cup (diameter = 50 mm) to match the typical size of human prostate. Five tubes (height/width = 40/15 mm) filled with varying sodium concentration (150, 80, 40, 20, and 0 mM) were inserted within the phantom. The phantom and prostatectomy specimens from patients with prostate cancer were centered and placed over the coil loop and scanned at room-temperature. For the specimen scan, a calibration marker (i.e., a tube with 80 mM sodium concentration) was placed next to the specimen and used for sodium quantification. The phantom was imaged using ^1H T2-weighted sequence (TSE; TR/TE 6100/98 ms, in-plane resolution $220 \times 220 \text{ mm}^2$, thickness 2 mm, BW 225 Hz/pixel, and total acquisition 3 min), ultra-short ^1H sequence (spiral GRE sequence; TR/TE 50/0.27 ms, flip angle 5° , FOV $100 \times 100 \times 100 \text{ mm}^3$, iso-resolution 0.8 mm, and acquisition time 3 min), and Na^{23} imaging sequence (spiral GRE sequence; TR/TE 100/0.27 ms, flip angle 90° , FOV $100 \times 100 \times 100 \text{ mm}^3$, iso-resolution 3.0 mm, NEX 8, and acquisition time 15 min). The specimens were imaged using ^1H T2-weighted (TSE; TR/TE 5650/103 ms, in-plane resolution $400 \times 400 \text{ mm}^2$, thickness 3 mm, BW 205 Hz/pixel, and total acquisition 1 min) and Na^{23} sequence (TR/TE 100/0.27 ms, flip angle 90° , FOV $100 \times 100 \times 100 \text{ mm}^3$, iso-resolution 3.0 mm, matrix $34 \times 34 \times 34$, NEX 16, and acquisition time 20 min). The signal intensities were measured over the phantom and specimen regions and compared with reference sodium concentrations.



[Results and Conclusions] As anticipated, excellent correspondence between ^1H and Na^{23} images was found in the phantom and specimens (Figs 1 and 2). The linear relationship between the signal intensities and the sodium concentration was observed in the phantom measurement (Fig. 1). As reported previously [3], tumors demonstrated low signal intensity on both ^1H and Na^{23} images (Fig. 2). We postulate that our findings reflect increased cellularity and reduced sodium concentration in prostate tumors, compared with normal prostate gland which is primarily consists of glandular tissues of a high degree of extra-ductal secretion [3]. More rigorous histopathological correlation with the degree of sodium concentration is needed. Further investigation is also required to see whether or not Na^{23} imaging would provide added diagnostic values over conventional ^1H imaging in prostate cancer imaging. Our on-going research includes the optimization of the dual-tuned coil to improve SNR and increased number of imaging prostatectomy specimens and in vivo prostate.

In conclusion, ^1H and Na^{23} imaging of prostate was feasible using a dual-tuned surface endorectal coil at 3T. Continued improvement of this technique may facilitate the improved diagnosis of prostate cancer.

[Reference] [1]. Jemal et al., CA Cancer J Clin 55:10-30, 2005. [2]. Jacobs et al. Techn Cancer Res Treat, 3:543-550 (2004). [3]. Lenkinski et al., ISMRM abstract (2002). [4] George et al., ISMRM, 2009, submitted.