

## High spatial and spectral resolution (HiSS) MRI of the prostate: a pilot study

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**Introduction:** Currently, prostate biopsies use sparse core sampling, and the lack of reliable guidance significantly impairs their accuracy. [1,2] In addition to providing high-quality MR images, high spectral and spatial resolution (HiSS) MRI can probe water resonance structure, and thus may be sensitive to higher perfusion, hypoxia, deposits of certain proteins, etc. in cancerous tissue. This could in turn improve accuracy of prostate biopsy, by better visualization of cancerous tissue. *In vivo* HiSS MR imaging presents challenges in terms of imaging time and adequate signal-to-noise ratio (SNR), and has not yet been reported in human prostate. Here we demonstrate clinical feasibility of *in vivo* prostate HiSS imaging, examine the water resonance structure, and compare HiSS images to clinical fast spin echo (FSE) images.

**Methods and materials:** Five healthy volunteers were scanned on a 1.5 T GE SIGNA™ scanner, using a 4-element phased array torso coil. Clinical MR prostate sequences included an axial fat-saturated FSE sequence (TR/TE = 3500/102ms, ETL = 12, acq. matrix 256x256, NEX = 2, slice thick. 4 mm, in-plane resolution approx. 1.5 x 1.5 mm), and not a spectroscopic sequence. After the clinical protocol, multi-slice axial HiSS sequence was acquired, implemented using echo-planar spectroscopic imaging (EPSI; TR/TE = 1000/128 ms, flip angle 30 or 60 deg., 1 x 1 mm in a 4 mm thick slice spatial, and 2.6 Hz spectral resolution, NEX = 1). Signal from 4 coil elements was combined as the sum-of-squares, providing adequate SNR for B0 field map calculation. Further post-processing uses B0 maps to remove fat and background signal by fitting water and fat peaks of the obtained proton spectrum to Lorentzian forms. [3] Thus a high-resolution (2.6 Hz) spectrum of pure water resonance was calculated in each voxel, and the shape and structure of the water resonance was examined. Images proportional to water resonance peak height were constructed and compared to corresponding FSE images.

**Results:** The spectral resolution of HiSS data was high enough to resolve possible water resonance structure. [4] However, in the healthy prostate of all five volunteers the water resonance had a Lorentzian shape and did not show internal structure. HiSS imaging provided markedly better spatial resolution and anatomic detail than conventional clinical FSE images, as can be seen in Figure 1. The prostate capsule and seminal vesicles were visualized well. Fat signal was completely removed in HiSS images, which improved anatomical detail (e.g. arrows). While signal loss in the proximity of the rectum was an issue in some slices, this will be remedied in the future by use of an endo-rectal coil.

**Conclusion:** *In vivo* HiSS MRI of the prostate was successfully implemented in healthy volunteers, with clinically feasible times and adequate SNR. The water resonance is sufficiently resolved for detection of possible internal structure, (e.g. asymmetric broadening, peak splitting etc.) though none was detected in healthy volunteers. HiSS water peak height images provide better fat suppression and morphologic detail than clinical FSE images. Future imaging of patients with prostate lesions due for biopsy will allow characterization of water resonance spectrum in malignant lesions in the prostate, and assessment of sensitivity and specificity of HiSS prostate MRI. HiSS imaging of the water resonance is a novel approach to visualizing cancerous tissue in prostate, and is likely to benefit the biopsy accuracy.

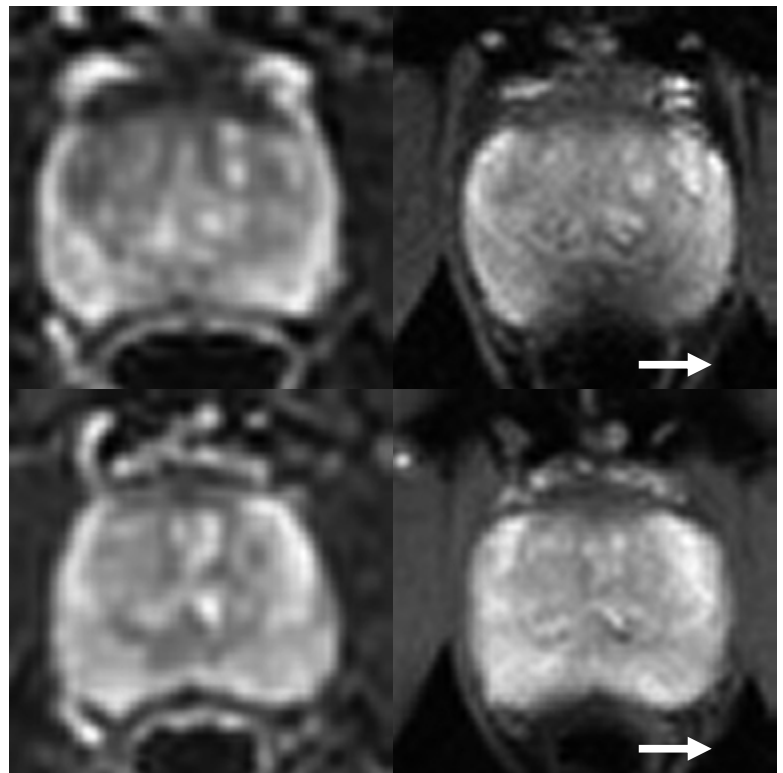


Figure 1: Fat-saturated FSE images (left) and corresponding HiSS water peak height images (right) are shown for two representative slices. The HiSS images show higher morphologic detail, and superior fat suppression (arrows).

- 1) Numao, Kawakami, Yokoyama, *et al.*, *European urology*, 52:1663-1668, 2007.
- 2) Miyake, Kurahashi, Takenaka, *et al.*, *Urologia internationalis*, 79:302-306, 2007
- 3) Medved, Du, Zamora, *et al.*, *JMRI* 18:442-448, 2003.
- 4) Medved, Newstead, Fan, *et al.*, *MRM* 52:193-196, 2004.