Intraprostatic Lipid Spectroscopic Imaging of the Prostate Cancer

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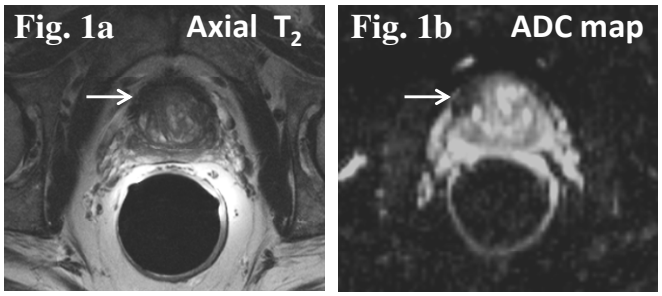
Purpose: The lipogenic fatty acid synthase (FAS) is responsible for de novo fatty acid and triglyceride synthesis in tissue. Recently, FAS has been characterized as an oncogene and its overexpression is reported in several cancers which include that of the prostate (1). The altered lipid deposition of cancerous tissue thus can potentially be an independent biomarker for cancer aggressiveness monitoring. In this work, functional MR spectroscopic imaging (MRSI) is used to quantify prostatic lipid concentration for prostate cancer.

Methods: Twenty six prostate cancer subjects were studied under an IRB-approved protocol. Based on biopsy findings and radiologist's input, two dimensional (2D) MRSI data with water suppression in combination with periprostatic fat suppression were acquired on a Siemens TIM Trio system. A total of eight saturation bands (six for periprostatic fat and two for water) were used to minimize signal contamination from those outside the prostate. Parameters used for the 2D MRSI sequence are: TR/TE: 1500 ms/30 ms; slice thickness: 5 mm; FOV 60 cm^2, 24 X 24 acquisition matrix, resulting in a 2.5 x 2.5 x 5 mm^3 voxel size. Each 2D MRSI acquisition lasts about 9.5 minutes and up to three MRSIs were acquired. At least for one slice location, MRSI data were also acquired without water suppression (periprostatic lipid is always suppressed) to provide water reference signal. For lipid MRSIs, RF transmitting employed the whole body coil and RF receiving used only a prostate endorectal coil (Bayer's Medrad, Indianola, PA). Other clinical quality T_2-weighted images and Apparent Diffusion Coefficient (ADC) maps were generated using a combination of the endorectal coil, the Spine Matrix, and flexible Body Matrix coil arrays.



Results: **Figure 1a** shows an axial view T_2-weighted image of a prostate slice and **1b** displays the ADC map for the same location. The MRI suspicious lesion (white arrows) was identified by the participating radiologist based on focal reduced signal intensity on the T_2-weighted image and the focal reduced ADC values on the ADC map at the same location. The axial 2D lipid MRSI slice was then prescribed at this location. For this location, MRSI data were acquired with and without water suppression. **Figure 2a** shows a residue water signal percentage map (residual water peak signal from the water suppressed MRSI over that of total signal without water suppression). The relatively low ratio values within the prostate provide a nearly perfect nature segmentation of the prostate. The apparent lipid signal map is shown in **2b**. Due to the generally low spatial resolution (small matrix size) used in MR spectroscopy imaging, signal bleeding from adjacent voxels to the volume of interest is often noticeable. Thus correction is required to restore the proper image intensity. Signal contributions (contaminations) from all pixels outside the prostate (i.,e., all pixels from the black masked area in **2b**) to those within the prostate are estimated and subtracted from that of **2b**. The result is shown in **2c**. The elevated lipid intensity (image left) matches very well with the lesion area shown on the T_2-weighted MRI and the ADC map. From a standard 12-core needle biopsy, prostate cancer is found from two cores sampling this location.

Discussion: When used in conjunction with current multiparametric prostate MRI, our study shows that lipid MRSI provides complementary details to those of multiparametric prostate MRI. For coverage and resolution considerations, current protocols used MRSI rather than single voxel spectroscopy for intraprostatic lipid quantification. Lipid MRSI for the prostate encounters potential signal contaminations from subcutaneous fat (fold-over artifact) and periprostatic lipid (signal bleeding from adjacent MRSI voxels due to broader point spread function, PSF). While the former is readily mitigated by using only the endorectal coil (reception profile not shown) with RF reception range limited to the vicinity of the prostate, the latter can be largely addressed with post-processing PSF correction. At 24 x 24 matrix size, our PSF analysis shows that the periprostatic lipid signal noticeably affects up to 3 pixels into the prostate, similar to that shown in a PSF-choice study (2) of the prostate. Thus, lipid heat map can be significantly affected near the surface area of the prostate, resulting in artificially elevated lipid signals without PSF correction (2b). Though timely inefficient, our concept-proving approach acquires non-water-suppressed MRSI for at least the most interested slice location. Besides providing a reference signal, the added benefit also includes that of a nearly perfect image contrast for prostate segmentation (2a), which in term can be used for prostate masking and subsequent PSF analysis of signal contamination from residual periprostatic lipid.

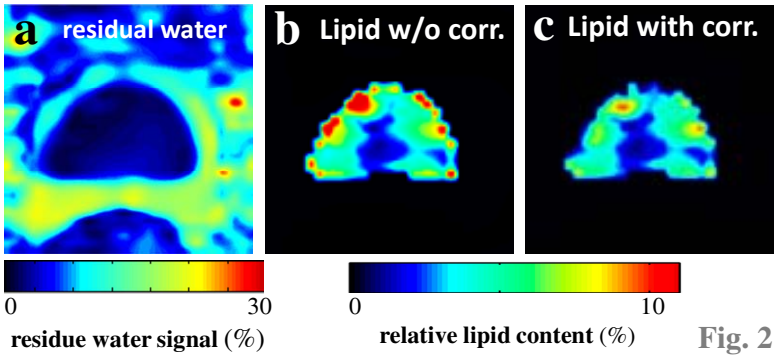


Fig. 2

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Reference: **1.** Migita, Ruiz, Fornari, Fiorentino, Priolo, Zadra, Inazuka, Grisanzio, Palescandolo, Shin, Fiore, Xie, Kung, Febbo, Subramanian, Mucci, Ma, Signoretti, Stampfer, Hahn, Finn, Loda, *J. Natl Cancer Inst.,***101**:519-32, 2009. **2.** Panych, Roebuck, Chen, Tang, Madore, Tempany, Mulkern, *Magn Reson Med.,***68**:1376-82, 2012.