Water Unsuppressed 1H MR Spectroscopic Imaging Of The Prostate

Nassim Tayari[1], Arend Heerschap[1], and Alan J. Wright[1]
[1]*Dept. of Radiology, RadboudUMC, Nijmegen, Gelderland, Netherlands*

Target audience: MR spectroscopists interested in acquisition and quantification of MRSI data of the prostate

Purpose/Background

Proton MR spectroscopic imaging is commonly performed with water signal suppression to avoid artifacts from side bands of the large water signal caused by system oscillations. However, this signal can be very useful for referencing purposes as estimation of absolute metabolite values and to correct for various metabolite line shape deformations. For these purpose it is common to acquire a separate MRS data set without water suppression, but this takes quite some time, and thus rarely used in a clinical setting. Therefore, it remains an attractive option to attempt to acquire MRS(I) data without water suppression and implement proper processing to remove the water side bands. Several studies have explored non water suppressed ^{1}H MRS(I) of the brain [1,2].

The *aim of this study* was to develop water unsuppressed 3D MRSI of the prostate and validate its value in a number of prostate cancer patients. We have used this technique to generate choline concentration maps for localization of prostate tumours.

Methods Prostate Cancer patients underwent standard mpMRI exam. The semi-LASER sequence developed for water unsuppressed spectroscopic imaging which allows resolution of extra metabolite peaks [3] is utilized to collect MRSI data from each of these patients. An algorithm based on the method of Dong et al. [1] was developed to process ^{1}H MRSI data of the prostate and water signal is used for absolute metabolite quantification(fig. 1). The large water signal is filtered from the metabolites and it is used as an internal reference for zero and first order phase correction as well as frequency correction. Taking the modulus spectrum of the data at this stage suppresses the water sidebands. The filtered metabolites are fitted based on the lineshape function derived from the water signal along with a model baseline. These water and baseline signals were subtracted from the spectrum to leave just the metabolites which were fitted with the model lineshape. Choline concentration maps were generated from this data. The choline +spermine+creatine over citrate (CSC/C) ratio was also calculated for each fitted voxel.

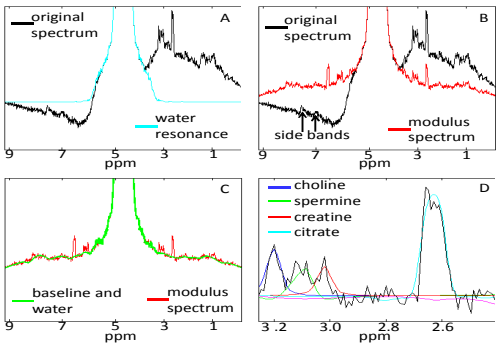


Figure 1. A) Raw spectrum with the filtered water signal B) The modulus spectrum of the phase corrected data suppresses the side bands. C) The model baseline function is subtracted from the data. D) A final fitting performed on the modulus spectrum

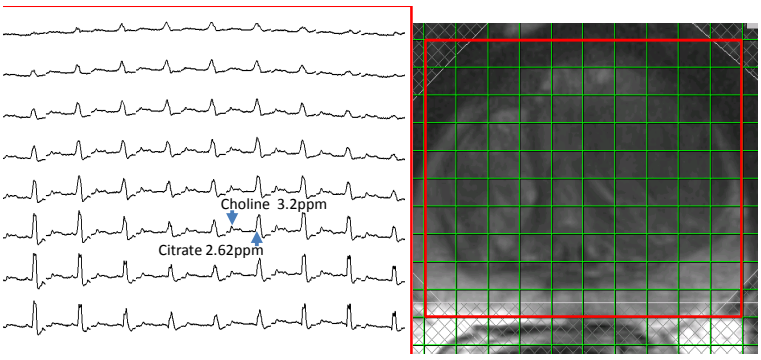


Figure 2: Slice showing metabolite peaks of interest in data acquired with water unsuppressed spectroscopy

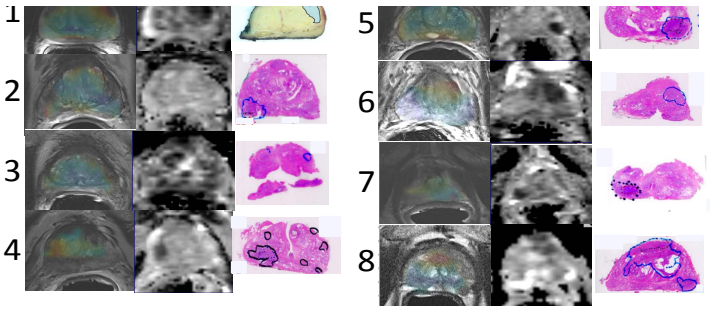
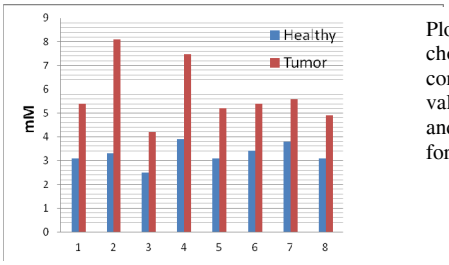


Figure 3 : Representative ^{1}H MRSI slices from all 8 of the patients shown as choline concentration maps (violet to red at 0-11mM) at the major tumour foci. The diffusion weighted image from the same location is given along an equivalent axial slice through the prostatectomy specimen with the location of tumour foci indicated.

Results Water unsuppressed spectroscopy (fig.2) showed that choline concentration correlates with regions with a high significant Gleason score (fig. 3) by comparison with the histopathology data and an assigned position with reference to T2-weighted and DWI imaging. In voxels that co-localise with tumour the estimated choline concentration correlates with the CSC/C ratio with an average coefficient of 0.64+/- 0.20 (standard deviation) whereas citrate correlates with a coefficient of -0.56+/- 0.10. In healthy tissue these correlations with the CSC/C ratio are 0.38+/-0.21 for choline and 0.57+/- 0.11 for citrate.

Discusstion The water unsupressed spectroscopic imaging data acquisition provides absolute quantification of the metabolites with the limitations of assuming non-significant variations for T1 and T2 relaxation phenomena. In healthy tissue the CSC/C ratio has a stronger correlation to citrate than choline suggesting that the ratio is more dependent on the former metabolites concentrations whereas in tumour tissue the two metabolites have an equally strong influence on this ratio. This suggests that in tumours the CSC/C is equally influenced by the displacement of benign tissue as it is on the increase of proliferation amongst tumour cells. Separating these metabolic biomarkers out allows for a choline concentration map that may act as a more specific marker for proliferative growth.



Plot 1: Absolute choline concentration (mean value) in healthy and tumor region for 8 patients.

References [1] Serrai H et al. J. Magn Reson 154 (2002); [2] Dong Z et al. Magn Reson Med 55 (2006).[3] Kobus et al . Magn Reson Med 2013 .

Acknowledgments: This work was supported by EU project TRANSACT .