On the importance of quality assurance in spectroscopic imaging of prostate

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INTRODUCTION: Spectroscopic imaging of prostate (SI) aided by dedicated endorectal coils (ER) has gained considerable interest recently as it provides high SNR and spatial resolution and allows one to detect signal changes, in particular, of the metabolites such as citrate (Cit) and choline (Cho) [1], characterizing the prostate cancer generally with a reduced ratio between Cit and Cho. Although the diagnostic statements are based on the obtained data and the quality of the data and accuracy of the methods used are important for a correct diagnosis, a routine quality assurance of prostate spectroscopy is lacking. In this contribution, we duplicated a typical clinical prostate SI as performed commonly [2] by using a homogenous phantom to assess the accuracy of ratio-based results.

METHODS: A 1.5 Tesla whole-body MR scanner (Siemens Symphony), equipped with a standard ER coil for reception and body coil for excitation was used for MR imaging and recording of the spectra. PRESS volume selection was used (TR/TE=650/120ms, NEX=5,voxel size= 6mmx6mmx6mm,1024 time data points, spectral width 1250 Hz, acquisition time 11 minutes). A 500 ml cylindrical phantom filled with an aqueous solution of 20 mM Cit and 20 mM Cho was used. ER coil was not inflated to reduce susceptibility effects [3] but was firmly attached to the phantom. Routine post-processing used clinically was performed which included interpolation to a 16x16 matrix, Fourier transformation, manual zero-order phase correction within each voxel and frequency domain curve fitting. The ratio between Cit and Cho signals were plotted over the SI slice. In a second measurement, we performed single voxel spectroscopy (SVS) using an identical phantom containing 20 mM Cit and 20 mM creatine (Cre). We moved the voxel away from the ER coil by 5 mm in each measurement and recorded Cit, Cre and unsuppressed water signals. Peak areas were calculated in the frequency domain by taking the integral. It should be stressed that the sign of the peak was taken into account for SVS measurements and only the inner lines of Cit were used in integral as outer lines show fast phase modulations [4].

RESULTS AND DISCUSSION: Figure 1 shows the map of ratio between Cit and Cho signals obtained by following the routine data acquisition and post-processing available on the 1.5 T clinical MR scanner. Notably, the deviation in ratios over the same slice is very large and can be as high as 72 %. On the other hand, the plot of normalized signal intensities obtained by single voxel measurements given in figure 2 shows that signal intensities follow a typical decay curve away from the coil and ratio between signal remains to be almost constant. It should be noted that although Cit is a J-coupled metabolite and might behave differently to varying flip angles [5], the excitation is achieved with body coil with very good homogeneity. Therefore B_1 field is homogeneous and metabolites and water signal drop in a similar fashion away from the coil. Therefore, the ratio-based results as shown in figure 1 are disconcerting as the same excitation (body coil) and reception (ER) is used for prostate SI. The main difference is probably the curve fitting applied clinically. Citrate signal is modeled as the sum of two Gaussians sitting adjacent to one another to mimic a doublet and the sign of the peaks is not taken into account during curve fitting. Future work is underway to repeat the same procedure using a realistic prostate phantom and to report on the extent of errors introduced quantitatively.

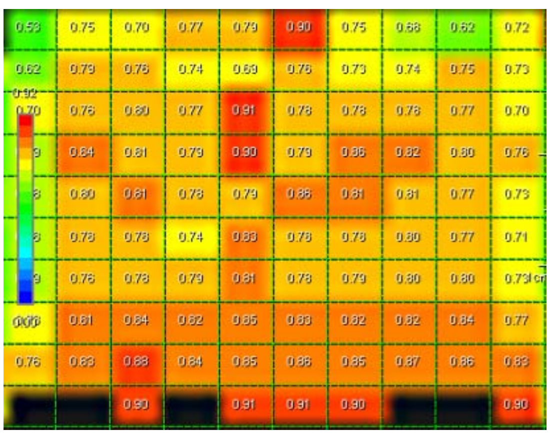

figure 1

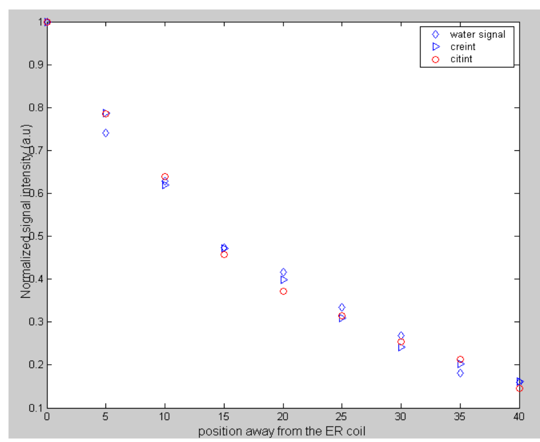

figure 2

References:

[1] Kurhanewicz et al. 1993, 12th SMRM, p.212
[2] Heerschap A. et .al., 2003, IMAPS (report),
[3] Schenck JF et al. 1996, Med Phys, 23(6), 815-50
[4] Schick F et al. 1993, Magn. Reson. Med., 29,38-43
[5] Schick F et al. 1996, Magn. Res. Imag. ,14, 663-672