3T MR spectroscopic imaging with and without endorectal coil in localizing prostate cancer: an initial experience

D. Yakar[1], S. Heijmink[2], J. Barentsz[2], C. Hulsbergen - Van de Kaa[2], J. Fütterer[2], and T. Scheenen[2]
[1]Radboud University Nijmegen Medical Centre, Nijmegen, Gelderland, Netherlands, [2]Radboud University Nijmegen Medical Centre

Introduction
Prostate cancer (Pca) is the most commonly diagnosed noncutaneous cancer among Western men. Knowledge of the location and spatial extent of the disease within the gland is crucial for proper treatment selection. Digital rectal examination, histologic grade from biopsy and PSA levels in serum are a number of diagnostic tools that are being used in daily clinical practice to assess the extent and location of Pca. However, these are often inaccurate or inadequate. Magnetic resonance spectroscopic imaging (MRSI) provides a noninvasive method of localizing Pca and can aid in assessing the extent and location of Pca. At higher field strengths of 3T the signal-to-noise ratio increases and the need for an endorectal coil (ERC) could be redundant. Nonetheless, the need for an ERC at this field strength is yet to be determined.

Purpose
To determine the Pca localization accuracy of 3D MRSI and to compare MRSI with and without ERC at 3T.

Materials and methods
From the first cohort of patients examined with 3D-MRSI in our institution at 3T between October 2005 and January 2006 eighteen consecutive patients with histologically proven Pca underwent 3T 3D-MRSI (PRESS pulse sequence) with and without an ERC. Imaging parameters were as follows: TR/TE 750/145; acquisition bandwith, 1250 Hz; and voxel resolution of 7 x 7 x 7 mm without and 6 x 6 x 6 mm with ERC. The prostate was divided into 14 regions of interest (ROIs). Four readers (with different levels of experience) independently rated (on a five-point scale) their confidence that cancer was present in each of these ROIs using a standardized scoring system. This scale was based on the choline-creatine-to-citrate and choline-to-creatine ratios for the peripheral zone and for the central gland determined before by Scheenen et al [1]. with a score of 1 represented Pca definitely absent and 5 represented Pca definitely present. Readers were allowed to rate ROIs as non-ratable when ratios were not reliably fitted due to low signal-to-noise ratios of the metabolite spectra. For statistical analysis (SPSS version 16.0), the sensitivity, specificity, negative predictive value (NPV) and positive predictive value (PPV) were calculated by dichotomizing (cut-off point of above 3 was considered malignant) the readings. Areas under the receiver operating characteristic curve (AUC) were determined. A difference with a P value of less than .05 was considered significant. These findings were correlated with whole-mount prostatectomy specimens, of which the presence of Pca was independently transferred to the 14-segment prostate scheme.

Results
In total 504 ROIs (18 patients x 14 ROIs x 2 (with and without ERC)) had to be rated for presence of Pca. With the standard of reference 50 ROIs were found to be containing Pca.

	MRSI - AUC	Sensitivity	Specificity	NPV	PPV	MRSI + AUC	Sensitivity	Specificity	NPV	PPV
Reader I	0.55	65%	43%	84%	20%	0.60	80%	34%	89%	21%
Reader II	0.62	30%	88%	85%	37%	0.65	20%	92%	82%	39%
Reader III	0.59	33%	70%	82%	20%	0.68	32%	87%	85%	37%
Reader IV	0.67	42%	74%	83%	30%	0.72	57%	82%	85%	45%

Table 1. Diagnostic performance of Pca localization. Level of experience: reader I (novice), reader II (mid-level experienced), reader III (experienced), reader IV (most experienced). MRS - =MRS without ERC, MRS + = MRS with ERC.

	MRS -	MRS +
Reader I	3% (6/252)	0%
Reader II	18% (50/252)	22% (62/252)
Reader III	8% (20/252)	14% (36/252)
Reader IV	18% (45/252)	19% (48/252)

Table 2. Percentages of non-ratable ROIs per reader.

In Table 1 the results of the different readers are summarized. For all readers the AUC improved with using the ERC. Figure 1 shows an example of an ROI rated as Pca definitely present, which was confirmed by histopathology. Only for reader III the difference between the AUC of the MRSI with and without ERC was significant ($p<0.05$). For the other readers this difference was not significant. Overall there were more ROIs not ratable on the MRSI with ERC than without ERC (table 2).

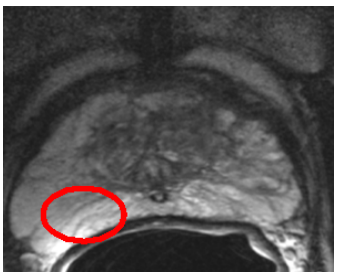
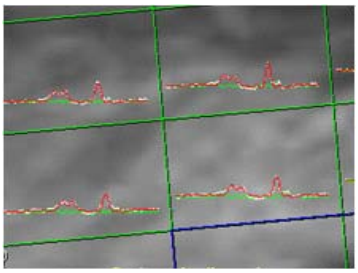
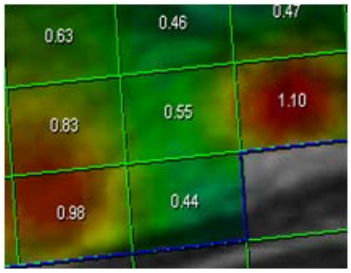


Figure 1A. T2-weighted image with a positive ROI on MRSI (red circle).



1B. The measured spectrum of the ROI (white line), overlaid with fit (red line), and residual between data and fit (green line).



1C. The choline-creatine-to-citrate ratios of the ROI.

Discussion and conclusion
Overall the AUC for all readers was quite low, with and without the use of an ERC. Emphasis have to be made on the fact that these results concern an initial experience based on a first cohort of patients examined at 3T with 3D-MRSI in our institution. In our experience more recent data of patients examined with 3D-MRSI at 3T in our institution are far more promising due to higher signal-to-noise ratios resulting in better fitted spectra and less non ratable ROIs. Non-ratable ROIs were found more often in MRSI with ERC at ROIs located at the ventral part of the prostate. Which could be explained by the decrease of the signal-to-noise ratio at distances further away from the ERC. This study has been of great value and increased our experience in obtaining 3D-MRSI at 3T. If the diagnostic performance of spectroscopic imaging at 3T does not increase in future studies it should be omitted as a diagnostic tool in the localization of Pca. In conclusion for an experienced reader 3T MRS for localizing Pca has a high specificity and a low sensitivity. Using an ERC at 3T MRS is more accurate compared to non-ERC MRS in localizing Pca. For one reader this improvement was statistically significant. Overall there were more ROIs non-ratable on the MRS with ERC than without ERC.

References 1. Scheenen et al. Radiology 2007; 245:507-16.