

Multiparametric 3T prostate MRI in patients with elevated PSA and no previous biopsy

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Purpose

To investigate the role of 3 Tesla multi-parametric MRI (mpMRI) and MRI-targeted biopsy using visual coregistration in patients with elevated PSA (>4 ng/ml), no previous biopsy and low risk of prostate cancer (PCa).

Methods

Fifty-five patients at 2 institutions (41 at institution A and 14 patients at institution B) underwent mpMRI, consisting of anatomical T2-weighted imaging (T2wi), diffusion weighted imaging (DWI), proton magnetic resonance spectroscopy (¹H-MRS) and dynamic contrast enhanced MRI (DCE-MRI), using surface array coils followed by MRI targeted TRUS-guided biopsy (TB) in addition to 12 core systematic biopsy (SB). MR imaging was performed using the same type of 3 T MRI scanner (Verio, Siemens) at both of the institutions with the following protocol: T2wi: TSE, TR/TE 6400-8600/101ms, FOV 200x200mm², voxel size 0.6x0.6x3.0mm; DWI: SE epi, TR/TE 5543/80ms, FOV 260x260mm², voxel size 2.0x2.0x3.0mm², b-values of 0, 100, 200, 300, 350, 500s/mm²; ¹H-MRS: PRESS, TR/TE 750/140ms, FOV 96x96mm², nominal voxel size 8.0x8.0x8.0mm; DCE: 3D VIBE, TR/TE 5.43/1.87ms, FOV 200x200mm², voxel size 1.3x1.3x3.0mm, 60 frames. Anatomical T2wi and parametric maps of DCE (Toft model (1) with population-averaged AIF (2)) were evaluated visually while DWI (cut-off value for ADC lower than 1250 mm²/s in PZ, 1100 mm²/s in CZ/TZ) and ¹H-MRS (cut-off for Cho+Cr/Cit value higher than 0.46 in PZ and 0.62 in CZ/TZ) quantitatively for the presence of PCa. If a lesion was highly suspicious on at least 2 imaging sequences, the lesion was marked as a PCa and subsequently targeted during TRUS-guided biopsy. In calculation of diagnostic accuracy values (sensitivity, specificity, accuracy, AUC_{combined}) for combinations of individual imaging sequences at least 2 highly suspicious ratings were required to give the final rating of that combination as indicative for PCa. In addition, AUC_{added} values for combinations of sequences (raters) were calculated using added ratings of each individual sequence. Diagnostic accuracy values were assessed on patient and sextant level, using systematic and targeted biopsy as a gold standard. Clinically significant cancer (SPCa) was defined as 3 mm PCa of Gleason score 3+3 or any Gleason grade 4.

Results

The median (range) PSA values was 7.4 (4 to 14) ng/ml. Prostate cancer and SPCa was diagnosed in biopsy cores of 37 (67%, 37/55), 30 (55%, 37/55) patients, respectively. Suspicious lesion based on mpMRI was present in 40 patients. The sensitivity, specificity, accuracy and AUC_{combined} values on patient level for detection of clinically significantly PCa for T2wi, DWI, ¹H-MRS and DCE-MRI were 85%, 46%, 67%, 0.655, respectively. The similar values for T2wi and DWI were 76%, 68%, 72%, 0.719. Using systematic and targeted biopsy as a gold standard, PCa was present in 100 (30%, 100/330) sextants in 55 patients. Clinically significant PCa was present in 69 (21%, 69/330) sextants. Diffusion weighted imaging had the highest accuracy (83%) and AUC (0.751) values for detection of PCa. However, the differences between individual imaging sequences and their combinations were very subtle. Similarly, the difference in the accuracy and AUC values of different sequences for detection of SPCa were relatively small (Table 1). Proton magnetic resonance spectroscopy and its combinations with other sequences demonstrated the highest specificity while relatively low sensitivity. The overall PCa detection rate per core for SB was 22% (142/660) while for TB was 43% (33/77).

Conclusions

The use of T2wi+DWI was shown to be an accurate tool for initial decision management and targeting biopsy in patients with elevated PSA. The additional use of DCE-MRI and ¹H-MRS provided only limited additional benefit in this patient population.

References

1. Tofts PS. J Magn Reson Imaging 1997; 7:91-101.; 2. Parker GJ et al. Magn Reson Med 2006; 56:993-100

Table 1. Diagnostic accuracy on sextant level

	Clinically significant PCa				
	sensitivity	specificity	accuracy	AUC _{combined}	AUC _{added}
1 rater:					
T2wi	73(*)	79(p<0.01)	77	0.76(p=0.47)	0.76(p=0.47)
DWI	66(p=0.25)	92(p<0.01)	87	0.79(*)	0.79(*)
DCE	71(p=0.71)	85(p<0.01)	82	0.78(p=0.84)	0.78(p=0.84)
MRS	34(p<0.01)	97(*)	86	0.66(p=0.02)	0.65(p=0.02)
2 raters:					
T2wi+DWI	60(p=0.16)	93(p<0.01)	86	0.77(p=0.68)	0.82(p=0.74)
T2wi+DCE	67(*)	91(p<0.01)	86	0.79(*)	0.81(p=0.55)
T2wi+MRS	32(p<0.01)	98(*)	85	0.65(p=0.01)	0.79(p=0.34)
DWI+DCE	59(p=0.57)	96(p<0.01)	88	0.77(p=0.75)	0.84(*)
DWI+MRS	34(p<0.01)	98(NA)	85	0.66(p=0.02)	0.79(p=0.47)
DCE+MRS	31(p<0.01)	98(NA)	85	0.64(p=0.01)	0.8(p=0.49)
3 raters:					
T2wi+DWI+DCE	71(NA)	88(p<0.01)	84	0.79(p=0.77)	0.83(p=0.99)
T2wi+DWI+MRS	62(p=0.01)	93(p=0.06)	87	0.77(p=0.54)	0.82(p=0.903)
T2wi+DCE+MRS	71(*)	90(p<0.01)	86	0.81(*)	0.81(p=0.66)
DWI+DCE+MRS	61(p=0.01)	96(*)	89	0.78(p=0.69)	0.83(*)
4 raters:					
T2wi+DWI+DCE+MRS	76	87	84	0.79	0.83