Multiparametric MRI diagnostic value in a case of prostate cancer

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ABSTRACT

Prostate cancer (PC) is one of the most prevalent malignant tumour in men, especially in elderly patients. The aim of this paper is to present and illustrate the utility of multiparametric (MP) MRI in the diagnostic of PC. A 66 years old patient with clinical suspicion of PC was explored by MP MRI. The MR examination included T2-wi, dynamic contrast-enhanced (DCE) MRI and diffusion-weighted imaging (DWI) acquisitions. The final MR diagnosis was prostate tumor with the TNM-stage T4 N1 Mx. Radical prostatectomy revealed a Gleason score 7 (4+3) adenocarcinoma with extraprostatic extension. This case report shows the utility of MP MRI exam in characterizing and for the management of PC.

Key words: prostate cancer, MP MRI, ADC map, DCE

OBJECTIVES

The aim of this paper is to present and illustrate the usefulness of MP MRI exam in the detection, localization and staging of prostate cancer in a 66 years old male patient.

CASE REPORT

The patient was admitted with an elevated PSA level of 37,5 ng/ml and clinical suspicion of PC. His past medical history were non-contributory.

MP MRI prostate examination was performed using a 1.5 T superconducting MR system with a phased array surface coil. An anti-peristaltic drug was injected intravenously before the examination in purpose to reduce peristaltic movement of the ileum and sigmoid colon. MP MRI examination was performed using T2-wi, dynamic contrast-enhanced (DCE) MRI and diffusion-weighted imaging (DWI) using multiple b factor: 0, 1000 and 1500 s/mm². For optimal

prostate characterization we use the same thickness and spacing in the axial plane, as well as sections perpendicular to the rectal wall or positioned in the plane of the seminal vesicles and ejaculatory ducts. The extracellular gadolinium-based contrast agent was intravenously injected (0.1 mmol/kg of body weight) followed by a 20 ml saline flush. The image acquisition parameters are summarized in *table 1* (1).

For the MR imaging analysis we have used PI-RADS scoring system proposed by the European Society of Urogenital Radiology (ESUR) in 2012 (2). The PI-RADS scoring system uses a five-point scale (2, 3):

- Score 1: clinically significant disease is highly unlikely to be present;
- Score 2: clinically significant cancer is unlikely to be present;
- Score 3: clinically significant cancer is equivocal;
- Score 4: clinically significant cancer is likely to be present;
- Score 5: clinically significant cancer is highly likely to be present.

The day after the MRI examination was performed a prostate biopsy, and 7 weeks later, the patient underwent radical prostatectomy.

RESULTS

MP MRI

T2-w images shows a few areas of low signal intensity with irregular shape and ill-defined contours located in the base and mid part of the prostate gland involving the right peripheral zone (PZ) and the transition zone (TZ).

DWI and (apparent diffusion coefficient) ADC map shows restricted diffusion in these areas appearing with high signal intensity on DWI, respectively low signal intensity on the ADC map. The ADC values of prostate cancer and non-cancerous peripheral and transitional tissue at $b = 0-1000$ and $0-1500 \text{ s/mm}^2$ are summarized in *table 2*.

DCE MRI shows a type 2 of time intensity-curve (gadolinium concentration) representing a plateau enhancement after initial uptake.

The MRI findings are suggestive for a prostatic tumor (*figure 1*).

The right seminal vesicle appears in low signal intensity on T2-w images with restricted diffusion and type 2 of time intensity-curve (plateau), associating thickening of the ductus deferens and obliteration of

Table 1 - Procedure details (1)

Sequences	type	TR (ms)	TE (ms)	NAQ	Thickness/Spacing (mm)	Matrix	FOV (cm)
T2-wi sagittal	FSE JET cover the entire pelvis	5907	120	1	4 / 0.4	272X272	24X24
T2-wi axial	FSE cover the entire prostate	4876	120	2	4 / 0.4	352X352	32.2X26.9
T2-wi oblique	FSE cover the entire prostate with sections perpendicular to the rectal wall, respectively in the plane of the seminal vesicles and ejaculatory ducts	4389	120	4	4 / 0.4	352X352	24X24
STIR coronal	FSE cover the entire pelvis, optional sequence when we evidenced bone lesions	3950	48	1	4 / 1	320X320	38X30
T1-wi axial	SE cover the entire prostate	625	15	1	4 / 0.4	352X224	32.2X26.9
DWI axial	SE EPI cover the entire prostate with b values of 0, 1000 and 1500 s/mm^2	4218	84	9	4 / 0.4	144X144	28/28
MR-dynamic contrast enhanced (DCE MRI)	3D FFE (Fast Field Echo) FatSat Dynamic cover the entire prostate in axial plane; duration 10 seconds per cover, repeated for 5-10 minutes continuous scan	4.8	1.9	1	4 / 0 interpolated to 2 / 0	176X180	23X23
T1-wi late phase	3D FFE Flow Compensation Isotropic Fat Sat cover the entire prostate	30	5.5	1	0.6 / 0	240X240	30X30

Table 2 - The ADC values of cancerous and non-cancerous tissue at b = 0-1000 and 0-1500 s/mm²

b value (s/mm ²)	ADC values $\pm$ standard deviation (X10 ⁻³ mm ² /s)		
	Prostate cancer	Non-cancerous tissue	
		PZ	TZ
b = 0-1000	0.89 $\pm$ 0.11	1.65 $\pm$ 0.16	1.29 $\pm$ 0.20
b = 0-1500	0.81 $\pm$ 0.15	1.57 $\pm$ 0.13	1.31 $\pm$ 0.14

the angle between the prostate and seminal vesicle; the MRI findings are suggestive for a tumour extension into the right seminal vesicle (*figure 2*).

Furthermore, the prostatic tumor is located adjacent to the bladder neck with loss of low T2 signal in bladder muscle and abnormal enhancement; the MRI findings are suggestive for bladder neck involvement (*figure 3*).

In this case report, lesion was classified according to the PI-RADS scoring system as follows:

- T2-wi, PI-RADS 5 (invasive behaviour - right seminal vesicles and bladder neck);
- DWI/ADC map, PI-RADS 5 (high signal intensity on the high b-value DWI with low signal intensity on ADC map);
- DCE MRI PI-RADS 3 (type 2 gadolinium enhance-

ment curve and enhancement at an unusual place).

The MRI exam also revealed a right iliac tumoral adenopathy (*figure 4*).

There was no evidence of bone lesions on coronal STIR acquisition covering the entire pelvis.

In this case the final diagnosis was prostate tumor with the following TNM-stage T4 N1 Mx.

Histological findings

The biopsy of prostate confirmed the diagnosis of prostate cancer with Gleason score 7 (3+4) on the right side, respectively 7 (4+3) on the left side.

Radical prostatectomy revealed a Gleason score 7 (4+3) adenocarcinoma with extraprostatic extension (*figure 5*).

DISCUSSION

The zonal anatomy of prostate can be easily characterized using T2-w images (1, 4). In older male patients, the transition zone increase in size due to benign prostatic hypertrophy (BPH) and the central zone is compressed and most often difficult to identify on MR images (5).

Figure 1 - Prostate cancer / MP MRI – T2-wi (a), DWI with b value of 1000 s/mm² and ADC map (b, c), DCE-MRI and time-intensity (gadolinium concentration) curve (d-early phase, e-late phase, f-ROI in tumoral mass and g-the corresponding graph). Tumoral mass (arrows) located in the prostate gland involving the right PZ and the TZ with irregular shape and ill-defined contours; this lesion appear hypointense in T2-wi (a), with restricted diffusion (b and c) and early, rapid and persistent enhancement / type 2 of the dynamic curve (plateau) (d-g)

Figure 2 - The right seminal vesicle invasion / MP MRI – T2-wi (a-coronal and b-axial), DWI with b value of 1000 s/mm² and ADC map (c, d), DCE-MRI and time-intensity (gadolinium concentration) curve (e-early phase, f-late phase, g-ROI in the right seminal vesicle and h-the corresponding graph). The right seminal vesicle (arrows) appears in low signal intensity on T2-w images (a and b) with restricted diffusion (c and d) and type 2 of time intensity-curve (plateau) (e-h), associating obliteration of the angle between the prostate and seminal vesicle (arrowhead)

Figure 3 - The bladder neck involvement / MP MRI – T2-wi (a and b), DWI with b value of 1000 s/mm² and ADC map (c, d), DCE-MRI and time-intensity (gadolinium concentration) curve (e-early phase, f-late phase, g-ROI located adjacent to the bladder neck and h-the corresponding graph). The prostatic tumor (stars) is located adjacent to the bladder neck, with loss of low T2 signal in bladder muscle (black arrow), restricted diffusion (arrowheads) and abnormal enhancement (white arrows)

Figure 4 - Right iliac tumoral adenopathy (arrow) (coronal STIR)

In prostatic hyperplasia, DCE MRI and DWI may reveal variably abnormal findings, such that the T2-wi become more accurate in differentiating suspicious areas from benign lesions (6).

Nicolas Barry Delongchamps et al. reported that the combination of DWI and DCE MRI to T2-wi, significantly increase diagnostic performance in cancer detection in the PZ, as well as Gleason score, but fails in the TZ (7); the sensitivity of T2-wi alone, T2-wi+DCE, T2-wi+DWI and T2-wi+DCE+DWI, for the PZ were 63%, 79%, 81% and 80%, respectively, and for the TZ were 71%, 47%, 71% and 53%, respectively (7); the specificity of T2-wi alone, T2-wi+DCE, T2-wi+DWI and T2-wi+DCE+DWI, for the PZ were 98%, 92%, 93% and 97%, respectively, and for the TZ were 98%, 77%, 98% and 83%, respectively (7).

Brian Kim et al. analyzed the diagnostic accuracy of

Figure 5 - Histological findings - Gleason score 7 (4+3) acinar adenocarcinoma with extraprostatic extension and tumoral lymphadenopathy; H&E 10x (a) and 5x (b-d); a - perineural invasion; b - extracapsular extension in periprostatic fibroadipose tissue with perineural invasion; c - seminal vesicle invasion; d - lymphatic metastasis

surface coil magnetic resonance imaging at 1.5 T for local staging of prostate cancer in patients with elevated risk (8); the sensitivity and specificity in tumor detection for patients with high risk were 94.6 % and 71.4 %, respectively and for patients with intermediate risk were 93.8 % and 100 %, respectively (8); regarding detection of extraprostatic extension, the sensitivity and specificity for patients with high risk were 92.3 % and 93.1 %, respectively, and for patients with intermediate risk were 50 % and 77.8 %, respectively (8); concerning detection of seminal vesicle tumoral invasion, the sensitivity and specificity for patients with high risk were 88.9 % and 88.6 %, respectively, and for patients with intermediate risk were 66.7 % and 100 %, respectively (8).

The differential diagnosis of prostate cancer must be performed with:

- BPH which appears as well-defined areas with intermediate signal intensity on T2-wi located in the central gland; this is mainly composed of transition zone which appears increased in size, compressing the central and peripheral zones (1, 3, 5, 9).
- Chronic prostatitis, scars or post-radiation therapy changes which appears as areas of low signal intensity on T2-wi frequently located in the peripheral zone, with triangular or linear shape and without mass (1, 4, 5, 10).
- Blood within prostate after biopsy which leads to high signal intensity on T1-wi and low signal intensity on T2-wi (1, 4, 5, 11).
- Prostatic calcifications which appears as small areas with low signal intensity on both T1-wi and T2-wi sequences (1).

CONCLUSIONS

This case report shows and illustrate the utility of MP MRI examination in the prostate cancer diagnosis, specifying the role of each MR acquisition. The combination of T2, DWI and DCE MRI increase the diagnostic

performance in the detection and extension of PC, but with different sensitivity and specificity for the PZ and the TZ. The MRI findings provides important data for the management of prostate cancer.

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