Repeat multiparametric MRI in prostate cancer patients on active surveillance Version 2

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Abstract

Introduction: This study was conducted to describe the repeat multiparametric MRI (mpMRI) changes occurring in prostate cancer (PCa) patients during active surveillance (AS), and to study possible associations between mpMRI-related parameters in predicting prostate biopsy (Bx) Gleason score (GS) upgrading >3+3 (GU) and protocol-based treatment change (TC).

Materials and methods: The study cohort consisted of 76 AS patients with GS 3+3 PCa and at least two consecutive mpMRIs of the prostate performed between 2006 and 2015. Patients were followed according to the Prostate Cancer Research International Active Surveillance (PRIAS) protocol and additional mpMRIs. The primary end points were GS upgrading (GU) (>3+3) in protocol-based biopsies and protocol-based TC.

Results: 53/76 (69%) patients had progression (PIRADS upgrade, size increase or new lesion[s]), 18/76 (24%) had radiologically stable disease, and 5/76 (7%) had regression (PIRADS or size decrease, disappearance of lesion[s]) in repeat mpMRIs during AS. PIRADS scores 4 to 5 in the initial mpMRI was associated with GU (p=0.008) and protocol-based TC (p=0.009). Tumour progression on repeat mpMRIs was associated with TC (p=0.045) but not with GU (p=1.00). PIRADS scores 4-5 predict GU (sensitivity 0.80 [95% confidence interval (CI); 0.51-0.95, specificity 0.62 [95% CI; 0.52-0.77]) with PPV and NPV values of 0.34 (95% CI; 0.21-0.55) and 0.93 (95% CI; 0.80-0.98), respectively.

Conclusion: mpMRI is a useful tool not only to select but also to monitor PCa patients on AS.

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Protocol

Data acquisition

Step 1.

The retrospective study cohort consisted of 76 active surveillance patients with Gleason score 3+3 prostate cancer and at least two consecutive multiparametric magnetic resonance images (mpMRI) of

the prostate performed between 2006 and 2015 in the Helsinki University Hospital.

Multiparametric MRI protocol parameters

Step 2.

MpMRI is a combination of T2-Weighted Imaging and at least two functional techniques that make cancer detection characteristics more specific. The mpMRI parameters include T2-Weighted Imaging (T2WI), Diffusion-Weighted Imaging (DWI) with Apparent Diffusion Coefficient (ADC) mapping, and Dynamic Contrast Enhancement (DCE).

Imaging was performed between April 2007 and May 2015 using a 3.0 T Philips Achieva MRI scanner with 4 mm (all sequences until 2012) or 3 mm (T2WI from 2013 on) slices. The mpMRI protocol evolved over the study period according to current knowledge at the time in question. The European Society of Urogenital Radiology (ESUR) guidelines for mpMRI were followed since their publication in May 2012.

T2-weighted Imaging (T2WI)

Step 3.

T2WI provides the best available detection of prostatic anatomy and capsule. Is it used for cancer detection, localization and staging.

Dynamic Contrast Enhancement (DCE)

Step 4.

Gadolinium-based contrast solution in administered intravenously into the patients blood circulation prior to imaging. It emphasizes the differences in benign and malignant tissues by the vascular properties of the tissues. The enhancement was assessed visually. Signal intensity curves were available after the implementation of ESUR prostate MRI guidelines. Contrast-enhanced images without dynamic curves, however, were available over the whole period. DCE is used for detection and localization of the tumor.

Diffusion-Weighted Imaging (DWI)

Step 5.

DWI measures the motion of free water molecules within a tissue in various magnetic gradients called b values. Diffusion is inversely proportional to cellularity and cell membrane integrity, which is different in malignant and benign tissues. DWI improves cancer detection and is used to calculate ADC values (see below).

In this study, the highest b value used in DWI for tumor detection was raised from 600 to 800 in June 2012, and finally to 2000 in September 2013.

Apparent Diffusion Coefficient (ADC)

Step 6.

ADC represents a quantitative assesment of water diffusion. Cancer shows lower ADC values than healthy tissue. ADC values also correlate to tumor aggressiveness: the lower the ADC values, the poorer the differentiation of the tumor. Calculation of ADC depends on b values used in imaging and, therefore, a definite cut-off value for malignancy can not be determined.

ADC maps are used for detection, localization and local staging of the tumor.

Multiparametric MRI image reporting

Step 7.

Every parameter was scored according to Prostate Imaging Reporting And Data System version 1 (PIRADS) criteria by four experienced uroradiologists with at least five years of experience in interpreting prostate MRIs. Inter-reader agreement was not evaluated.

A total of 58 patients had at least one of their mpMRIs prior to PIRADS era, and retrospective reading of these scans was done according to PIRADS v1 by one uroradiologist (AK) who was blinded to the subsequent clinical data of the patients. The overall PIRADS score was compiled using T2 as primary determining sequence in prostatic transition zone and DWI in peripheral zone. Tumour size was measured in three dimensions (AP x CC x LAT x 0.5) on T2WI.