Multiparametric MRI in the pre- and postoperative prostate cancer patients

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Purpose

Positive prostate biopsy is currently mandatory to diagnose prostate cancer [1]. Biopsy schemes with 10-12 cores taken from the standard locations under transrectal ultrasound (TRUS) control are used [2]. Imaging modalities (TRUS, contrast enhanced CT and routine MR T1-weighted images - T1WI - and T2-weighted images - T2WI) have little role in detection of malignant lesions within prostate [3] and do not allow for their precise sampling during prostate biopsy.

Our multiparametric MRI approach includes T2WI, DWI with ADC and dynamic contrast enhanced T1WI (DCE T1WI). The multiparametric MRI sensitivity and specificity in the detection and localization of prostate cancer in pre- and especially postoperative prostate cancer patients are not clear yet.

The purpose of this study was to determine the role and limitations of such multiparametric MRI in the diagnosis of prostate cancer (to increase the accuracy of the prostate biopsy) and in detection and exact localization of prostate cancer tissue in patients with biochemical relapse after radical prostatectomy.
Methods and Materials

Multiparametric MR images (DCE T1WI, T2WI, DWI with ADC) of male small pelvis of 53 prostate cancer patients were obtained on Siemens Magnetom Espree 1.5 T: I group - 30 clinically suspicious prostate cancer patients (median age 63 years, median PSA 8.4 ng/ml, median prostate volume 47 cm3); II group - 11 patients with biopsy proven prostate cancer (median age 55 years, median PSA 12.8 ng/ml, median prostate volume 44.5 cm3); III group - 7 patients with supposed local relapse after prostatectomy (median age 62, median PSA 0.4 ng/ml); 1 patient with prostate cancer relapse after radiotherapy, 1 patient after hormonal therapy, 1 patient with high residual PSA after prostatectomy.

Suspicious lesions were identified and were marked as suspicious or not on each of the MRI modalities (DCE T1WI, T2WI, DWI with ADC). Lesions were classified as peripheral or central depending on their location in the peripheral zone or the central lobe of the prostate. Lesions were marked on prostate pictures in three planes. Biopsies were done only in patients with prostate cancer suspicious areas on multiparametric MRI. In these patients MRI data influenced the number and location of the biopsy cores.

During biopsy all cores were marked as cores from specific suspicious lesions or from the non-suspicious areas. TRUS-guidance was done by several independent experts (ultrasound specialists as well as urologists).

The number and location of biopsy cores from the non-suspicious areas depended on the number and location of previous biopsy cores, prostate size, and time from the last biopsy. If it was the first biopsy we obtained standard cores first and then additional suspicious cores if needed. In case of two or more previous negative biopsies suspicious cores were obtained first and then standard areas were sometimes biopsied. Predominantly and solely suspicious cores were taken after two and three or more negative biopsies respectively. One to four cores were taken from each suspicious lesion.
Results

Pre-biopsy multiparametric MRI was done in 30 patients. In 25 of them suspicious areas were found. Typical findings are shown in Fig. 1 on page 5, Fig. 2 on page 5, Fig. 3 on page 6, Fig. 4 on page 7. 19 patients with suspicious MRI were biopsied and in 8 cases (42%) the biopsy was positive. 12 of them (63%) had one to three previous negative biopsies, the median age was 63, median PSA was 8.4 ng/ml, median prostate volume was 47 cm3. Among patients diagnosed with prostate cancer two were Gleason 3+4, and the rest had Gleason 3+3 score. Two of the positive biopsy patients had one previous biopsy and two had three previous biopsies. The median number of biopsy cores was nine in both positive and negative biopsy groups. The median of the cores from suspicious areas was four and five in the two groups respectively.

Five of the 28 (18%) suspicious areas in the transitional zone were positive on biopsy whereas 3 of 10 (30%) suspicious peripheral zone lesions turned out to be cancer-positive. In the rest of the cores from MRI-positive lesions benign prostatic hyperplasia was found on pathology.

71% of all cores from biopsy-positive MRI-suspicious lesions were positive. We therefore recommend to obtain three or at least two cores from each suspicious area to minimize the risk of missing cancer. There were three patients with one positive core not marked as suspicious. In all three cases it was a core from the same lobe and from the area adjacent to the biopsy-positive MRI-suspicious lesion.

In all 11 pre-prostatectomy patients with biopsy confirmed prostate cancer suspicious lesions were identified in prostate by MRI (DCE T1WI was not specific in 1 patient). Median age was 55 in this group, median PSA was 12.8 ng/ml and median prostate volume was 44.5 cm3. According to postoperative pathology lesions with cancer-to-benign tissue ratio of more than 30-40% were identified on MRI and almost all were contrast-enhanced.

4 of 5 patients with biochemical relapse after radical prostatectomy and PSA less than 1 ng/ml (median 0.38 ng/ml) had positive DCE T1WI. The example of local prostate cancer relapse MR-images is shown in Fig. 5 on page 8, Fig. 6 on page 9.
Images for this section:

**Fig. 1:** Low intensity signal in the right peripheral zone (prostate cancer with extracapsular extension) on T2-weighted image of a 50 years old patient with PSA 9.3 ng/ml. Gleason 3+4 prostate cancer was diagnosed on biopsy.

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Fig. 2: Diffusion weighted image of the prostate cancer in the right peripheral zone of the same patient.

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**Fig. 3:** Suspicious contrast enhanced area in the right peripheral zone.

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Fig. 4: Characteristic contrast enhancement line in the suspicious area.

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**Fig. 5:** Coronal T2 weighted image of the local prostate cancer relapse with urinary bladder wall invasion 11 years after prostatectomy in a 70 years old man. His PSA increased within 5 years from 0.5 to 2.5 ng/ml.

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Fig. 6: Transversal T2 weighted image of the local prostate cancer relapse with urinary bladder wall invasion in the same patient.

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Conclusion

Multiparametric MRI is complimentary to prostate biopsy in detecting and localizing prostate cancer. It helps to reduce the number of biopsy cores and increases the accuracy of prostate biopsy due to the targeted prostate sampling.

The sensitivity of cancer detection by multiparametric MRI is high but lesion areas with low cancer-to-benign tissue ratio are often not identified. The specificity of multiparametric MRI set methods separately is low. Multiparametric MRI did not have enough efficacy in the case of central lobe tumor location (transitional zone) where benign hyperplasia was more common than cancer. Active MRI contrast media uptake and high local signal of this zone on DWI related with periurethral tissue character.

All used methods of multiparametric MRI seem to be necessary and are complimentary in the detection of prostate cancer.
References


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