Dynamic-Contrast Enhanced MRI and MR-guided biopsy in the detection of Local Recurrence after Radiation Therapy for Prostate Cancer

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Introduction
Diagnosing local recurrence of prostate cancer after external-beam radiation therapy (EBRT) is usually done by measuring serum PSA level, performing a digital rectal examination (DRE), a TRUS-guided biopsy, and a bone scan. Each of these diagnostic tools have their own shortcomings (1). Although PSA kinetics have demonstrated a correlation with both clinical and biochemical failure, there is still no absolute cut off point or threshold to accurately predict for an individual patient whether he has local recurrence or distant metastases. Identifying local recurrence by TRUS and DRE after EBRT is challenging due to fibrosis and shrinkage of the prostate gland. The positive predictive value of TRUS-guided biopsies directed to suspicious lesions after radiotherapy is only 27%. The usefulness of a bone scan with low PSA levels is also of little benefit. Magnetic resonance (MR) imaging of the prostate after radiation therapy can be difficult to interpret. Especially with T2-weighted MR imaging it can be difficult to detect recurrence because of several patterns of signal intensity (SI) abnormalities. Dynamic contrast-enhanced MR imaging (DCE-MRI) is expected to be of added value in the detection of local recurrence of prostate cancer (2,3). An accurate tumor localization for local recurrence and distant metastases are of utmost importance in order to determine which therapy would be of best benefit for the patient. Furthermore, accurate tumor localization of local recurrence may also help in better targeting biopsies to suspected regions, such as MR-guided biopsies. The purpose of this study was to assess the potential of 3T MR guided prostate biopsy of tumor suspicious regions (TSR) on 3T DCE-MRI, to detect local prostate cancer recurrence following EBRT.

Methods
In this pilot study, 19 patients with prostate cancer previously treated with EBRT (> 1 year ago) followed by 3 consecutive rises in PSA underwent an endorectal coil 3T MRI examination. The imaging protocol, after fast evaluation of correct endorectal coil position, included the following sequences: first, T2-weighted turbo spin echo sequences were performed in axial, coronal and sagittal planes, covering the entire prostate and seminal vesicles. Second, 3D T1-weighted spoiled gradient-echo images were acquired during an intravenous bolus injection of a paramagnetic gadolinium chelate. Two radiologists in consensus determined TSR from T2-weighted MR images and multi-parametric pharmacokinetic (DCE-MRI derived) color maps - ktrans, Vc, Kep, and WashOut. The MR-guided biopsy imaging protocol consisted of T2-weighted turbo spin-echo images and TRUE-FISP (TRUFI) images in the axial and sagittal (fig.1) orientation. The MR images of the initial TSR localization MR examination were projected on a monitor, positioned next to the MR console. If a low-signal intensity lesion was evident on the original T2-weighted images (fig.2) or a focally enhanced area on the DCE-MRI was present (fig.3) and re-identified on the current T2-weighted images, a TSR re-identification was evident. An MR biopsy device (Invivo, Germany) was used in conjunction with a phased array coil, to perform prostate biopsies under 3T MR guidance after re-identification of a TSR. 15 Patients received MR guided biopsies while 4 due to evidence of metastatic disease, did not.

Results
The average duration of MR guided biopsies was 30 min. Mean PSA value was 6.96 ng/mL, and mean age was 72 years. In total 53 biopsy cores of 29 different TSR were obtained. The median number of cores taken per patient was 3 (range 2-5). Prostate cancer was found in 13/15 (positive predictive value of 87%) patients. 22/29 (positive predictive value of 76%) TSR were positive for tumor on biopsy. One TSR contained normal tissue, one TSR contained residual tumor with radiotherapy effects, while 5/27 of the remaining TSR contained radiotherapy induced reactive atypia (table 1). No procedure related complications occurred.

Conclusion
Despite EBRT induced morphological changes we were able to localize recurrence in the prostate in 87% of our patients with MR guided biopsies after DCE MRI at 3T. This indicates that 3T MR guided biopsy of 3T DCE-MRI tumor suspicious regions can improve detection of local prostate cancer recurrence following radiotherapy.

<table>
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<th></th>
<th>Total number</th>
<th>Positive on biopsy</th>
<th>Positive predictive value</th>
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<tr>
<td>Patient</td>
<td>15</td>
<td>13</td>
<td>(13/15) 87%</td>
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<tr>
<td>TSR</td>
<td>29</td>
<td>22</td>
<td>(22/29) 76%</td>
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Table 1. Summary of positive findings of local recurrence

References