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Prostate Cancer

Combination of Diffusion-weighted Magnetic Resonance Imaging and Extended Prostate Biopsy Predicts Lobes Without Significant Cancer: Application in Patient Selection for Hemiablative Focal Therapy

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Abstract

Background: Significant cancer in contralateral sides of the prostate that was missed on prostate biopsy (PBx) is a concern in hemiablative focal therapy (FT) of prostate cancer (PCa). However, extended PBx, a common diagnostic procedure, has a limited predictive ability for lobes without significant cancer.
Objective: To identify prostate lobes without significant cancer using extended PBx combined with diffusion-weighted imaging (DWI), which has the potential to provide pathophysiologic information on pretreatment assessment.
Design, setting, and participants: We conducted a prebiopsy DWI study between 2007 and 2012 that included 270 prostate lobes in 135 patients who underwent radical prostatectomy (RP) for clinically localized PCa.
Intervention: Participants underwent DWI and 14-core PBx; those with PBx-proven PCa and who were treated with RP were analyzed.
Outcome measurements and statistical analysis: Imaging and pathology were assessed in each side. Based on RP pathology, lobes were classified into lobes with no cancer (LNC), lobes with indolent cancer (LIC), and lobes with significant cancer (LSC). Predictive performance of DWI, PBx, and their combination in identifying lobes without significant cancer was examined.
Results and limitations: LNC, LIC, and LSC were identified in 23 (8.5%), 64 (23.7%), and 183 sides (67.8%), respectively. The negative predictive values (NPV) of DWI, PBx, and their combination were 22.1%, 27.8%, and 43.5%, respectively, for lobes with any cancer (ie, either LIC or LSC), and 68.4%, 72.2%, and 95.7%, respectively, for LSC. The NPV of PBx for LSC was improved by the addition of DWI findings ($p = 0.001$), with no adverse influence on the positive predictive value. Limitations included a possible selection bias under which the decision to perform PBx might be affected by DWI findings.
Conclusions: The combination of DWI and extended PBx efficiently predicts lobes without significant cancer. This procedure is applicable to patient selection for hemiablative FT.

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1. Introduction

Prostate-specific antigen (PSA) measurement has led to early detection of prostate cancer (PCa) at a stage with a minimal risk of influencing patients' quality or duration of life. However, whole-gland treatments are still standard practice for localized PCa because of the cancer's multifocality and heterogeneity.

Focal therapy (FT) is receiving increasing attention as an individualized treatment option to selectively eradicate biologically relevant disease while preserving uninvolved parenchyma to minimize treatment-related adverse effects [1,2]. Hemiablative FT, ablation of one-half of the prostate, might be the most feasible form of FT, and its best candidates are patients with a purely lateralized lesion [3]. In multifocal PCa, however, it has been reported that an index lesion determines clinical outcome and secondary lesions are unlikely to contribute to disease progression [4,5]. This suggests that FT targeting an index lesion alone may be sufficient when accompanied by active surveillance of the untreated areas harboring indolent foci [1,6,7]. This concept also raises the possibility that the indication for hemiablative FT could be expanded to bilateral PCa, which consists of a unilateral dominant lesion and indolent foci on the contralateral side. However, there has been no identification of lobes without significant cancer that are requisite for hemiablation.

Diffusion-weighted imaging (DWI), a magnetic resonance imaging (MRI) functional technique, has the potential to provide physiologic information on anatomic structures; malignant lesions show hyperintensity because of their tissue conditions, such as higher cellularity, which restricts water diffusion [8–10]. We began a prospective, prebiopsy MRI study in 2007, and the present study, one arm of this large-scale study, is aimed at establishing a practical procedure for predicting the absence of significant cancer. Considering the risk of undertreatment in patients undergoing FT, the negative predictive value (NPV) for lobes with significant cancer (LSC) is the index parameter of diagnostic methods. Therefore, we evaluated the NPV of prebiopsy DWI and 14-core prostate biopsy (PBx) and assessed whether, and to what extent, their combination improves the pretreatment diagnosis.

2. Materials and methods

2.1. Patients

Between November 2007 and February 2012, 629 men with PSA levels $\geq$2.5 ng/ml and $<$20 ng/ml and in clinical stage T1 to T2 on digital rectal examination (DRE) were enrolled. These subjects underwent both prebiopsy MRI and 14-core PBx. PBx-proven PCa was found in 318 men. Of these, 135 men who underwent radical prostatectomy (RP) without prior treatment were finally included in the present study analyses. The institutional review board approved our study and informed consent was obtained from each participant.

2.2. Transrectal ultrasound-guided biopsy sampling

Transrectal ultrasound (TRUS)-guided 14-core PBx, a combination of transperineal 8-core and transrectal 6-core biopsies, was performed. Seven cores were obtained from systematic sampling sites in each side (Fig. 1) [11,12].

2.3. Imaging protocol

MRI, including T2-weighted imaging (T2WI) and DWI, was carried out using a 1.5-Tesla imager (Achieva; Philips, Best, The Netherlands) with a 32-channel, sensitivity-encoding body coil. The parameters for DWI with single-shot echo planar imaging sequence were set as follows: repetition time, 5000 ms; echo time, 80 ms; matrix, 128 $\times$ 99; field of view, 300 $\times$ 255 mm; slice thickness, 4 mm; interslice gap, 0.4 mm; and three different b values (b = 0, 1000, and 2000 s/mm^2). Apparent diffusion

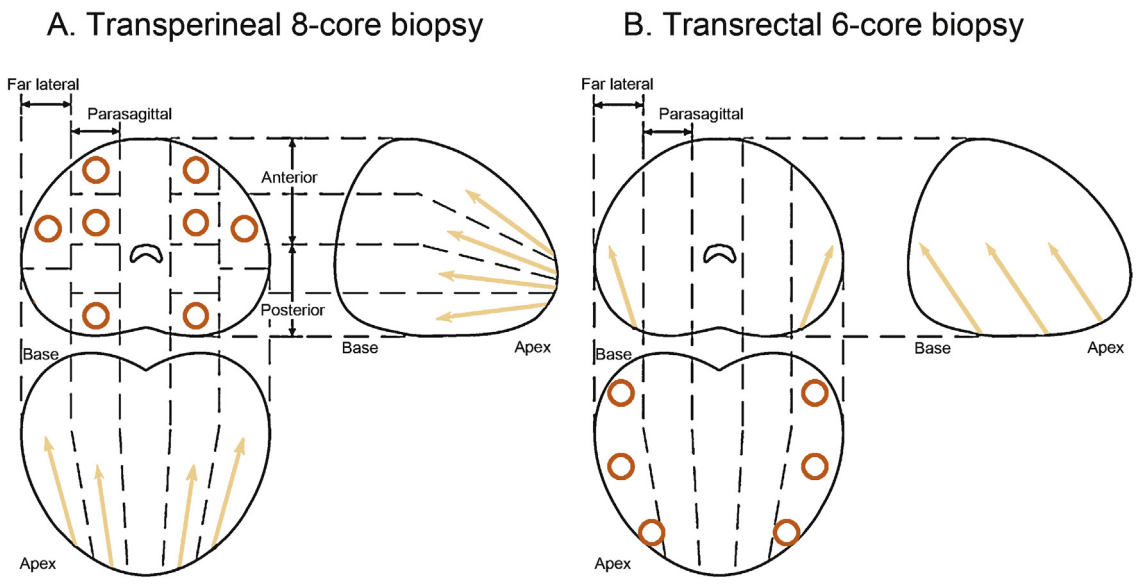

Fig. 1 – Transverse, sagittal, and coronal projections of the 14-core prostate biopsy scheme: a combination of (A) the transperineal 8-core sampling using the fan technique and (B) the transrectal 6-core sampling from far-lateral peripheral zone.