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Transition zone and anterior stromal prostate cancers: Evaluation of discriminant location criteria using multiparametric fusion-guided biopsy

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Abstract
Purpose: The purpose of this study was to evaluate precise location criteria on magnetic resonance imaging (MRI) to improve detection of transition zone (TZ) and anterior stroma (AS) prostate cancers using targeted MRI/transrectal ultrasound fusion biopsies as a reference standard.
Material and methods: Ninety-six men (mean age: 65 years ± 7.7 [SD] [range: 46—83 years]) with an elevated prostate-specific antigen (PSA) (PSA ≥ 4 ng/mL) who underwent standard and targeted biopsies on a TZ/AS suspicious lesion were included. The database was reviewed to assess topographical and morphological features of each suspicious lesion on MR images (T2-weighted anatomical images on 1.5 T MRI or 3 T) including PI-RADS score assessed by a senior radiologist.

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Histopathological examination of MRI-transrectal ultrasound fusion biopsy specimens was used as the reference standard.

Results: Ninety patients had a positive targeted biopsy with a median [IQR] lesion size of 16 mm [13—20 mm]. Homogeneous hypointensity on T2-weighted mages, lenticular shape, lack of capsule and indistinct margins were present in 77/90 (85%) patients. All TZ/AS prostate cancers were located in the anterior half of the prostate: 3% at the base, 69% in the mid gland and 28% at the apex. Lesions were mainly located close to or within the AS (74%) and more rarely laterally compressed close to the peripheral anterior horn.

Conclusion: Our results suggest that specific topographic criteria of TZ and AS prostate cancers could add independent information to the usual diagnostic criteria in prostate MRI. Transrectal ultrasound fusion-targeted biopsies based on these specific criteria improve volume estimation of prostate cancers with substantial impact for prognosis and treatment planning.

Transition zone (TZ) and anterior stromal (AS) tumors account for 15—30% of prostate cancers (PCa) and their detection pose a clinical challenge [1—3]. A systematic 12-core transrectal ultrasonographic (TRUS)-guided biopsy, based on random sampling of the peripheral zone (PZ) [3], was considered the optimal biopsy method [4] with a detection rate of prostate cancer of 27—40% [5—8]. However, the reliability of standard, systematic biopsies (SB) has been more recently questioned with the development of MR-targeted biopsies [9—11]. SB only samples the posterior part of the gland thus, leading to under-diagnosis of these lesions [8].

Magnetic resonance imaging (MRI) has a high sensitivity in the detection of prostate cancers not only in the PZ but also in the TZ [12,13] and allows MRI/TRUS-guided biopsies [14—16]. Prostate cancers located in the TZ or the AS of the prostate show some pathologic and clinical features that are different from the features shown by cancers located in the PZ [17,18]. Morphologic features of these tumors have been well described in recent literature including circumscribed homogeneous, moderately hypointense lesions, spiculated margins, lenticular shape, absence of a complete hypointense capsule [12,19,20]. In the PI-RADS score, the more features present, the higher the likelihood of clinically significant TZ cancer [21]. T2-weighted MRI remains the dominant sequence for detection of TZ cancers, although DW-MRI obtained with *b*-values as high as 2000 s/mm^2 may be useful [21,22].

However, the diagnostic performance of MRI in the TZ is variable across studies, with accuracies ranging from 66—84% [19,23] and TZ tumors remain difficult to detect mostly because of the hypointense and homogenous appearance of stromal nodules, which often show restricted diffusion [12]. Histopathological and imaging studies have suggested that topographical features such as location of the nodule within the TZ might be useful to detect prostate cancers [18,24,25]. TZ cancer detection could be improved if accurate diagnostic criteria could be added to the existing morphological features.

The purpose of this study was to evaluate precise location criteria on MRI to improve detection of TZ and AS prostate cancers, using targeted MRI/TRUS fusion biopsies as a reference standard.

Materials and methods

Study population

The institutional review board approved the current study and informed consent was obtained from all patients. The patients were recruited from our prospectively-maintained institutional database between January 2013 and January 2016. We consecutively included all patients with an elevated prostatic specific antigen PSA (4—10 nm/mL) referred for MRI/TRUS fusion-targeted biopsy of a TZ target lesion defined on pre-biopsy multiparametric MRI (PI-RADS v1 $\geq$ 9, v2 score of $\geq$ 3).

All patients had both SB and targeted biopsies (TB) (2 cores) during the same session. Among the 168 eligible patients, 72 were excluded because of positive prior biopsy (n = 14), prior treatment (n = 16), anterior horn of PZ lesion (n = 5), poor-quality MRI (n = 4). A total of 33 patients did not undergo multiparametric MRI in our institution, leaving 96 patients for final inclusion (Fig. 1).

Multiparametric MRI

All patients underwent multiparametric MRI using a pelvic phased-array coil: 64 patients (71%) underwent MRI examination at 1.5 T and 26 (29%) at 3 T (Siemens Healthineers, Erlangen, Germany). All examinations included unenhanced turbo spin-echo T2-weighted anatomical images that were acquired in two planes from the 1.5 T MRI scanner and a three-dimensional single sequence from the 3 T MRI scanner. Axial diffusion-weighted MRI of the prostate, using *b*-values of 50, 400, and 1400 s/mm^2 on the 1.5 T MRI and 50, 400 and 2000 s/mm^2 on the 3 T MRI, were performed with inline reconstruction from apparent diffusion coefficient (ADC) map. Dynamic contrast-enhanced MRI was obtained using a fat-saturated T1-weighted fast-field echo sequence after intravenous bolus injection of 20 mL of gadoterate

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