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Prostate Cancer

Multiparametric Magnetic Resonance Imaging (MRI) and MRI–Transrectal Ultrasound Fusion Biopsy for Index Tumor Detection: Correlation with Radical Prostatectomy Specimen

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Abstract

Background: Multiparametric magnetic resonance imaging (mpMRI) and MRI fusion targeted biopsy (FTB) detect significant prostate cancer (sPCa) more accurately than conventional biopsies alone.
Objective: To evaluate the detection accuracy of mpMRI and FTB on radical prostatectomy (RP) specimen.
Design, setting and participants: From a cohort of 755 men who underwent transperineal MRI and transrectal ultrasound fusion biopsy under general anesthesia between 2012 and 2014, we retrospectively analyzed 120 consecutive patients who had subsequent RP. All received saturation biopsy (SB) in addition to FTB of lesions with Prostate Imaging Reporting and Data System (PI-RADS) score $\geq$2.
Outcome measurements and statistical analysis: The index lesion was defined as the lesion with extraprostatic extension, the highest Gleason score (GS), or the largest tumor volume (TV) if GS were the same, in order of priority. GS 3 + 3 and TV $\geq$1.3 ml or GS $\geq$3 + 4 and TV $\geq$0.55 ml were considered sPCa. We assessed the detection accuracy by mpMRI and different biopsy approaches and analyzed lesion agreement between mpMRI and RP specimen.
Results and limitations: Overall, 120 index and 71 nonindex lesions were detected. Overall, 107 (89%) index and 51 (72%) nonindex lesions harbored sPCa. MpMRI detected 110 of 120 (92%) index lesions, FTB (two cores per lesion) alone diagnosed 96 of 120 (80%) index lesions, and SB alone diagnosed 110 of 120 (92%) index lesions. Combined SB and FTB detected 115 of 120 (96%) index foci. FTB performed significantly less accurately compared with mpMRI ($p = 0.02$) and the combination for index lesion detection ($p = 0.002$). Combined FTB and SB detected 97% of all sPCa lesions and was superior to mpMRI (85%), FTB (79%), and SB (88%) alone ($p < 0.001$ each). Spearman's rank correlation coefficient for index lesion agreement between mpMRI and RP was 0.87 ($p < 0.001$). Limitations included the retrospective design, multiple operators, and nonblinding of radiologists.

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Conclusions: MpMRI identified 92% of index lesions compared with RP histopathology. The combination of FTB and SB was superior to both approaches alone, reliably detecting 97% of sPCa lesions.
Patient summary: Multiparametric magnetic resonance imaging detects the index lesion accurately in 9 of 10 patients; however, the combined biopsy approach, while missing less significant cancer, comes at the cost of detecting more insignificant cancer.

1. Introduction

Multiparametric magnetic resonance imaging (mpMRI) and fusion targeted biopsies (FTBs) of the prostate have demonstrated excellent detection of significant prostate cancer (sPCa) while mitigating diagnosis of insignificant PCa [1,2]. The growing impact of mpMRI is supported by a standardized reporting system, Prostate Imaging Reporting and Data System (PI-RADS) [3,4].

The question of whether FTB alone should be performed is under debate [1,5–8]. Although Siddiqui et al [1] and Rastinehad et al [5] described that FTB using MRI and transrectal ultrasound (TRUS) fusion misses only approximately 5% of sPCa, Le et al [6] reported that 17% of sPCas were missed by fusion biopsy, suggesting use of a combined FTB and 12-core systematic biopsy to obtain best predictive accuracy. Aiming for detection of all sPCa, transperineal grid–directed template mapping techniques have been introduced [9]. Using transperineal saturation biopsy (SB) as a reference test, our group demonstrated that FTB missed 15% of Gleason score (GS) $\geq$3 + 4 PCa [7]. Thus, the combination of FTB and SB seems to be appropriate to achieve a maximally accurate biopsy [7]. However, due to variability in study methodology, only a correlation analysis of mpMRI, FTB and radical prostatectomy (RP) specimen may assess the rate of sPCa foci that are missed by mpMRI and different biopsy approaches [10]. Rosenkrantz et al reported a positive predictive value (PPV) for an exact match between suspicious lesions on MRI and whole-mount sections of 65% [11]. Turkbey et al observed sensitivity of 80% for the detection of sPCa and 94% for sPCa in the peripheral zone [12]. In the PI-RADS era, Baco et al found that the location of the index lesion was correctly assessed by MRI in 95% of patients [13]. Although Delongchamps et al [14] demonstrated that mpMRI missed 10% sPCa on a per-lesion basis but no sPCa on a per-patient basis, Le et al [15] analyzed multifocality and reported that mpMRI missed 20% of index lesions.

The first objective of our study was to evaluate the performance of mpMRI and different biopsy approaches to detect index lesions and sPCa in an RP specimen. Second, we characterized missed tumor foci. Because recent publications demonstrate that tumor volume (TV) might be important to characterize sPCa, we also analyzed TV differences between mpMRI and RP [13,16].

2. Patients and methods

2.1. Study population

Consecutive patients were registered into a prospective institutional review board–approved database (S011/2011) assessing MRI-targeted prostate biopsy at University Hospital Heidelberg between October 2012 and September 2014. Subgroups of this cohort were reported previously [7].

Inclusion criteria for the present study were mpMRI with PI-RADS scoring, MRI/TRUS fusion biopsy, and RP at our department. Pretreated patients were excluded from the analysis, which was done retrospectively.

2.2. Imaging

All mpMRI was performed using a 3T system without an endorectal coil (Magnetom; Siemens, Erlangen, Germany). Parameters of mpMRI sequences are described in Supplementary Table 1. All MRI images were analyzed prospectively by or under the supervision of two expert uroradiologists (M.R. and H.-P.S., 8 and 12 yr of experience, respectively), according to the 2012 European Society of Urogenital Radiology guidelines [3].

A PI-RADS $\geq$2 lesion on MRI was defined as biopsy target. Lesion volume was determined using Medical Imaging Toolkit software (German Cancer Research Center, Heidelberg, Germany). Reflecting clinical routine, radiologists were not blinded to clinical data.

2.3. Biopsy protocol

All men underwent transperineal FTB of MRI-suspicious lesions first (2–5 cores, median 2 per lesion, depending on lesion size) and then transperineally conducted SB (median 24 cores), as described previously [7]. A median of 28 biopsies were taken per patient with the number of biopsies adjusted to prostate volume [17].

Transperineal grid-directed SB performed under general anesthesia is the standard technique at our center, offering minimal risk of infection. Patients underwent FTB with rigid software registration using BiopSee (MEDCOM, Darmstadt, Germany) [18]. Biopsy operators had access to all mpMRI data with radiologist-marked lesions of interest. All targets were sampled under live TRUS visualization [18].

2.4. Histopathologic analysis

Histopathologic biopsy and RP specimen analyses were performed blinded to MRI data, under the supervision of one dedicated uropathologist (W.R., 10 yr of experience), according to International Society of Urological Pathology standards [19]. The index lesion in the RP specimen was defined as the lesion with extraprostatic extension, highest GS, or largest TV if GS was the same, in order of priority [19]. Lesion volume was determined using a predetermined correction factor (1.5) to correct for tissue shrinkage during fixation [20].

2.5. Statistical analysis

Patient demographics and detection accuracy of mpMRI, SB, FTB, and combination FTB and SB for index and nonindex lesions were analyzed descriptively.

To further evaluate the magnitude of differences in detection rates among mpMRI and different biopsy approaches, we calculated rate differences along with 95% confidence intervals, according to Tango

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