RESEARCH ARTICLE / *Araştırma Makalesi*

Biparametric Prostate MRI Shows Similar Diagnostic Accuracy Rates for Prostate Cancer Detection with Multiparametric MRI

Biparametrik Prostat MRG, Multiparametrik MRG ile Prostat Kanseri Tespiti İçin Benzer Tanısal Doğruluk Oranları Gösterir

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Abstract

Objective	To compare the diagnostic accuracy of bp-MRI with standard mp-MRI in the diagnosis of prostate cancer.
Materials and Methods	We retrospectively evaluated the bp-MRIs in comparison with mp-MRIs at 3 Tesla. Sensitivity, specificity, positive and negative predictive values (PPV and NPV), for bp- and mp-MRIs were calculated and compared.
Results	A total of 202 patients with a mean age of 62.4±11.8 years (range from 31 to 86 years) fulfilled the inclusion criteria. In patients with PI-RADS 4 and 5 lesions; the sensitivity, specificity, PPV, NPV for bp-MRI versus mp-MRI were 95.4%, 77.2%, 53.8%, 98.3% and 97.7% vs 73.4%, 50.5%, 99.1%, respectively.
Conclusion	Overall diagnostic accuracy was similar for the bp-MRI and the mp-MRI for PI-RADS 4 and 5 lesions.
Keywords	Biparametric prostate MRI, multiparametric prostate MRI; Prostate MRI, PI-RADS.

Öz

Amaç	*Prostat kanseri tanısında bp-MRG'nin tanısal doğruluğunu standart mp-MRG ile karşılaştırmak.*
Gereç ve Yöntemle	*3 Tesla MRG cihazında elde edilen bp-MRG bulguları mp-MRG bulguları ile karşılaştırmalı olarak retrospektif olarak değerlendirildi. Bp- ve mp-MRG'ler için duyarlılık, özgüllük, pozitif ve negatif prediktif değerler (PPV ve NPV) hesaplandı ve karşılaştırıldı.*
Bulgular	*Ortalama yaşı 62.4±11.8 yıl (31-86 yıl aralığında) olan toplam 202 hasta dahil edilme kriterlerini karşıladı. PI-RADS 4 ve 5 lezyonlu hastalarda; bp-MRG ve mP-MRG için duyarlılık, özgüllük, PPV, NPV sırasıyla %95.4, %77.2, %53.8, %98.3 ve %97.7, %73.4, %50.5, %99.1 idi.*
Sonuç	*PI-RADS 4 ve 5 lezyonları için tanısal doğruluk oranları bp-MRI ve mp-MRI için benzer bulundu.*
Anahtar Kelimeler	*Biparametrik prostat MRG; multiparameterik prostat MRG; prostat MRG; PI-RADS*

INTRODUCTION

Multi-parametric prostate magnetic resonance imaging (mp-MRI) is a well-established standard method for the detection of prostate cancer (PC). Patients with clinical suspicion of PC according to rectal examination and/or clinical history and elevated prostate specific antigen (PSA) are typical candidates for mp-MRI, although PSA is not a specific tumor marker. The Prostate Imaging Reporting Data System (PI-RADS) was published in 2012 and revised in 2015 and 2019 for standard imaging protocol and reporting.[1-3] The recommended mp-MRI contains T1- and T2-weighted (T1W and T2W) imaging, diffusion weighted imaging (DWI), and dynamic contrast-enhanced (DCE) T1W MRI sequences. The total scan time for a mp-MRI is approximately 30-40 min.[4] and obviously it is time-consuming. In addition, the over-estimated results of mp-MRI may cause unnecessary invasive biopsies and even over-treatment.[5] Over time, it was debated that mp-MRI with contrast enhanced images add little for detection and localization of the PC and therefore, new strategies to decline the total scan time and costs as low as possible without reducing the diagnostic accuracy, are receiving increased interest.

Bi-parametric prostate magnetic resonance imaging (bp-MRI) as a new protocol for prostate cancer detection, is simple, contains only two sequences (T2 weighted imaging and DWI) and takes about 15 min. without intravenous contrast material administration. Therefore, the abbreviated protocol offers benefits in terms of costs, scan time and eliminates the risk related to the use of gadolinium-based contrast agents. It was reported that bp-MRI could be sufficient for accurate diagnosis of PC with those advantageous features as a fast triage test prior to biopsy.[4,6-12]

In this study, we aimed to determine the diagnostic accuracy of the bp-MRI in comparison with the standard mp-MRI at 3 Tesla for patients with PI-RADS version 2.1 category of 4 and 5 lesions.

MATERİAL and METHODS

Study Concept and Inclusion Criteria

Local Institutional Review Board approved this retrospective single-center study and written informed consent was waived for this type of study. Study population covered patients from local radiologic database between January-2015 and February-2019. We retrospectively evaluated the T2-weighted and DWI images of the mp-MRIs as bp-MRI screening twice with an interval of two months, by two radiologists with an experience of 10 and 11 years in prostate imaging, in comparison with the standard mp-MRIs in biopsy-naïve patients with elevated prostate specific antigen (PSA≥3 ng/dl) and suspected PC. Mp-MRIs containing additional axial and dynamic contrast enhanced T1 weighted images were evaluated by both radiologists. Patients with prior prostate biopsy or surgery, and PSA<3 ng/dl were excluded. Also contraindications for MR imaging such as ferromagnetic implants, impaired renal function were taken into account. PI-RADS categories were assessed by using PI-RADS version 2.1 Pathological evaluation was made by trans-rectal ultrasound (TRUS)-guided prostate biopsy followed by radical prostatectomy in malignant patients. The reference standard was "TRUS biopsy" with 12 systematic biopsies or radical prostatectomy specimens.

Prostate MRI protocol

All of the MRI scans were obtained on a 3 Tesla MRI system (Achieva Philips Medical Systems, Healthcare, Eindhoven, the Netherlands) by using a 64-channel surface coil. Mp-MR protocol consisted of T1W turbo spin-echo without fat suppression, T2W turbo spin-echo, DWI (b values; 1500 and 2000), and dynamic contrast-enhanced (DCE) T1W 3D spoiled gradient-echo images. Bp-MR protocol involved T2W turbo spin-echo and DWI (b values; 1500 and 2000). Apparent diffusion coefficient (ADC) maps were calculated for each patient. MR imaging parameters and imaging acquisition times were given in Table 1.

Table 1. Prostate MRI protocol			
Parameter	T2WI	DWI	DCE-MRI
TR/TE (ms)	6056/80	4682/97	3.1/1.5
Flip angle (degree)	90	90	10
Echo train length	17	57	94
Field of view (mmxmm)	270x270	360x360	400x400
Matrix	800x800	144x144	176x176
Thickness (mm)	3.0	4.0	3.0
b values (s/mm2)		1500, 2000	

Meglumine gadoterate (Dotarem; Guerbet, Roissy CdG, France) was used as 0.1 mmol/kg with a flow rate of 2 mL/sec. Intravenous injection of hyoscinbutylbromid (Buscopan, 20 mg/mL, injection fluid, Boehringer, Ingelheim, Germany) was administered to decrease bowel peristalsis.

Image Interpretation

T2-weighted and DWI images of the mp-MRIs as bp-MRI screening were evaluated twice with an interval of two months, by two radiologists with an experience of 10 and 11 years in prostate imaging, Mp-MRIs containing additional axial and dynamic contrast enhanced T1 weighted images, were evaluated by both radiologists. The index lesion was defined according to the guidelines and PI-RADS categories were assessed by using PI-RADS version 2.1 (Fig. 1)

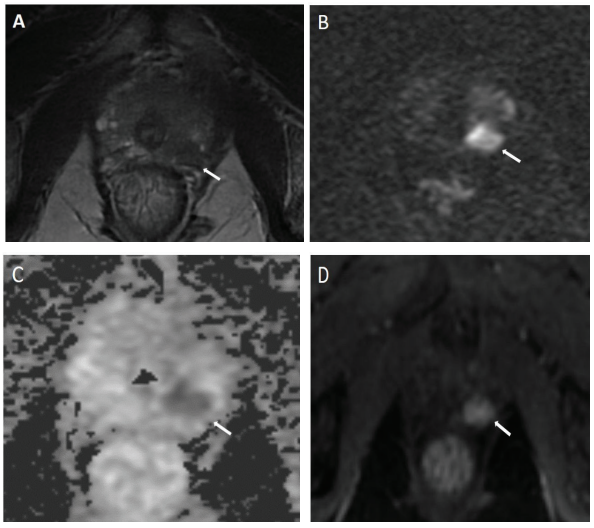

Figure 1. 74 year old biopsy naiive man with PSA level of 8.9 ng/mL.
(A) T2-weighted MR image shows a hypointense lesion with a partially circumscribed margin (arrow) in the left posterior peripheral zone at the apex, with a T2WI score of 4.
(B) DW image (b=1500 s/mm2) shows the lesion (arrow) has a focal markedly increased signal.
(C) Apparent diffusion coefficient map shows markedly low signal intensity (arrow), with a score of 4.
(D) DCE MR image shows early enhancement. Finally, The PI-RADS category of the lesion is 4.The lesion was proven to be prostate cancer with Gleason Score 3+4=7 by biopsy.

Statistical Analysis

Continuous variables were recorded as mean±SD. Sensitivity, specificity, positive and negative predictive values (PPV and NPV), diagnostic accuracy rates were calculated for bp- and mp-MRI. McNemar test was used for comparison of the diagnostic accuracy rates. Intra-observer (between-readings) and inter-observer (between-readers) agreement of bp-MRI were determined by intraclass correlation coefficient (ICC). We used Cicchetti's (1994) guideline for interpreting ICC.[13] Accordingly, an ICC ≤0.40 was considered as poor, between 0.40 and 0.59 was considered as fair, between 0.60 and 0.74 was considered good and ≥0.75 was considered as high. IBM SPSS Statistics,

version 21, for Windows (SPSS Inc., Chicago, IL, USA) was used for all statistical analyses. A P value of <0.05 was considered as statistically significant.

RESULTS

A total of 202 patients with a mean age of 62.4±11.8 years (range from 31 to 86 years) fulfilled the inclusion criteria. The mean PSA, PSA density and prostate volume were 11.6±22.6 ng/dl, 0.202±0.380 ng/dl/cm^3 and 64.2 ±30 cm^3, respectively. 90 patients underwent trans-rectal ultrasound (TRUS)-guided prostate biopsy. There were 96 peripheral zone lesions, 62 transitional zone lesions and 11 patients had suspicious lesions in both zones. 78 patients had PI-RADS 4 or 5 lesion according to the bp-MRI and 85 patients had PI-RADS 4 or 5 lesion according to the mp-MRI. Remaining 5 patients had PI-RADS 3 lesion and only 1 TRUS-guided biopsy was PC-positive among them. bp-MRI missed 1 lesion with PC-positive biopsy which was recorded as PI-RADS 4 at mp-MRI. There was no difference for the localization of the dominant lesions between readers. 44 men had pathologically-proven at least Gleason 3+3 prostate carcinoma (Gleason 6=25, Gleason 7=15, Gleason 8=3, Gleason 9=1) (Table 2).

Table 2. Clinicopathological Characteristics of study group

Item	Value
Age (year), mean± SD (range)	62.4±11.8 years (31-86)
PSA level (ng/mL)	11.6±22.6 ng/dl
PSAD (ng/mL/mL)	0.202±0.380 ng/dl/cm3
Prostate cancer lesions	44
Gleason score	
6 (3+3)	25
7 (3+4)	8
7 (4+3)	7
8 (4+4)	3
9 (4+5)	1

In patients with PI-RADS 4 and 5 lesions; the sensitivity, specificity, PPV, NPV for bp-MRI versus mp-MRI were 95.4%, 77.2%, 53.8%, 98.3% and 97.7% vs 73.4%, 50.5%, 99.1%, respectively for first reader and 94.1%, 75.3%, 50.6%, 96.5% and 95.7% vs 71.8%, 48.9%, 97.8% for second reader.

Bp-MRI gave 2 false negatives and, 46% false positives, whereas, mp-MRI gave 1 false negative and, 49.4% false positives respectively. The difference between diagnostic accuracies of bp-MRI vs mp-MRI was not statistically significant (McNemar test, P=0.213). Comparison of diagnostic accuracies of the bp-MRI versus the mp-MRI for PI-RADS category 4 and 5 lesions were given in Table 3.

Table 3. Comparison of Diagnostic Accuracy of the Abbreviated Biparametric versus the Full Multiparametric Protocol

Protocol	Bp-MRI	Mp-MRI
Sensitivity (%)	95.4	97.7
Specificity (%)	77.2	73.4
PPV (%)	53.8	50.5
NPV (%)	98.3	99.1

Intra- and inter-observer agreements of bp-MRI were high (Intra-class Correlation Coefficients were 0.89 and 0.79, respectively).

DISCUSSION

In patients with elevated PSA, prostate MRI before TRUS biopsy is becoming common and standard. In this case, MRI technique with low cost, short examination time and fewer side effects without changing the diagnostic accuracy will be preferred. Our results demonstrated that PPV, NPV, and PC detection rates were almost identical for bp-MRI and mp-MRI for PI-RADS 4 and 5 lesions. Mp-MRI; in particular DCE images, did not show an influence for detecting more PI-RADS category 4 and 5 lesions than bp-MRI in this series. Therefore, bp-MRI with a shortened protocol and without a contrast material might be utilized for patients with suspected prostate cancer.

It was reported many times in previous papers that bp-MRI has high diagnostic accuracy and can be used alternatively for detecting PC.[14-17], In a meta-analysis including 2383 pa-

tients, Niu et al[7] reported high diagnostic sensitivity (0.81) and specificity (0.77) for bp-MRI in detecting PC. Kuhl et al[8] reported similar sensitivity, specificity, positive and negative predictive values and diagnostic accuracies for both the bp-MRI and the mp-MRI in a comparative study including 542 patients and recommended the alternative utilization of bp-MRI without contrast and less time consumption. They also found increased false positives (additional 10 patients) detected by the mp-MRI than bp-MRI as in our study. For PI-RADS category determination, the inter-reader agreement was moderate in their study with a kappa of 0.681. Whereas, in the current study, we found a high intra- and inter-reader agreement for the bp-MRI most probably due to the involvement of only PI-RADS category 4 and 5 lesions, because they reported a high kappa of 0.818 for the differentiation of PC positive and PC negative MRIs. They also reported that bp-MRI could be used for the follow-up in patients with prostatectomy and suspected local recurrence.

Contrast-enhanced sequences might have overestimated the PI-RADS 4 lesions as focal or earlier enhancement could be detected in normal peripheral or transition zone.[18] However, it was also reported that too many false positives were better than any false negatives in order not to miss PC[4] and addition of intravenous contrast material into the bp-MRI protocol was beneficial for the detection of PC. But, although the study population was small, our study showed ignorable false negatives for both protocols and usage of contrast material might not be an obligatory component of the prostate MRI.

DCE-MRI is still an important and necessary examination method in the search for local recurrence after treatments such as radical prostatectomy or radiotherapy. DCE-MRI besides its beneficial features including better evaluation of prostatic capsular and neurovascular involvement of PC, better demonstration of extra-prostatic disease, it also causes an increase for the costs and total scan time. Vargas et al[2] found that DCE scan contributed a 3% increase for detection of PC located in the peripheral zone and no contribution for those in the transition zone. Barth et al[19] reported no significant difference between bp-MRI and mp-MRI in terms of PC detection rates. The shortened bp-MRI protocol might give similar diagnostic information as mp-MRI and be utilized as a triage in biopsy-naïve patients with high PSA and clinical PC suspicion. Delongchamps et al[14] showed significantly better accuracy of bp-MRI than T2W and DCE alone or a combination of T2W, DCE and DWI for detecting PC.

In the current small sample single-center study, we showed that the effectiveness of bp-MRI for the detection and localization of PI-RADS 4 and 5 lesions was not worse than mp-MRI. Both protocols had ignorable false negatives in this series. The main reason for higher false positives for mp-MRI than bp-MRI in this series might be secondary to that PI-RADS 4 lesions might be over-diagnosed by the mp-MRI because according to PI-RADSv2.1, if a PI-RADS 3 lesion in the peripheral zone (PZ) shows any kind of enhancement on DCE images, the score will be increased to PI-RADS 4. Most of the time, it is impossible to distinguish normal from malignant enhancement, especially in the transitional zone (TZ).[20] Thestrup et al[4] found higher number of false positives and false negatives for the bp-MRI than the mp-MRI in a retrospective study. However, in their study group, most of the patients had previous prostate biopsies which might affect the assessments and they used mostly PI-RADS version 1 for the categorization of the lesions which might cause under-utilization of T2W images.

There were some limitations in the current study. First of all, it is a single-center retrospective study including small number of patients. Second, the current study was based on a single vendor and the reproducibility of the results with different vendors is needed. Third, because of the small study group, the real false negative results might be underestimated and further studies with larger number of patients are needed.

In conclusion, sensitivity, specificity, PPV, NPV, and overall diagnostic accuracy rates were similar for the bp-MRI and the mp-MRI for PI-RADS 4 and 5 lesions.

The authors declare that they have no conflict of interest.

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