Original Article

Diagnostic Value of 1.5 Tesla Multiparametric MRI in Prostate Cancer

1.5 Tesla Multiparametrik MRG'nin Prostat Kanserinde Tanısal Değeri

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ABSTRACT

Introduction: Although prostate biopsy is still the gold standard in diagnosis of prostate cancer (PC), multi-parametric MRI (MpMRI) applied with 1.5 Tesla (T) or 3T systems has become an indispensable method in diagnosis. We aimed to compare "Prostate Imaging-Reporting and Data System version2" (PI-RADSv2) scores with pathology of patients who underwent MpMRG (1.5T) for the suspicion of PC.

Methods: Between January 2017 and January 2020, 52 patients (26 benign, 26 malignant patients) who underwent MpMRI followed by biopsy in our center due to suspicion of PC were included in our study. Age, prostate volume, blood PSA (prostate specific antigen) value, density and pathology of these cases were analyzed. The PI-RADSv2 assessment category was assigned for each patient by an experienced radiologist. The "Chi-square" test and "Student-t" test were used for statistical analysis.

Results: The mean prostate volume of benign group (96.4±77.7) was significantly higher than patients with cancer (47.4±17.3) (p=0.003). Mean PSA value and PSA density in patients with malignancy (PSA value, 13.7±16.5 ng/ml; PSA density, 0.33±0.46 ng/ml/cc) were significantly higher than benign group (PSA value, 6.8±3.3 ng/ml; PSA density, 0.09±0.05 ng/ml/cc, p<0,05). The sensitivity, specificity, negative predictive value and positive predictive value of MpMRI applied with 1.5 T system in detection of significant PC was 73.08%, 84.62%, 82.61% and 75.86%, respectively.

Discussion and Conclusion: Considering the high negative predictive value of negative MpMRI findings for significant PC due to PI-RADSv2, MRI can reduce unnecessary biopsy.

Keywords: Multiparametric magnetic resonance imaging, prostate biopsy, prostate cancer, Prostate Imaging–Reporting and Data System

ÖZET

Giriş ve Amaç: Prostat kanseri tanısında prostat biyopsisi halen altın standart tetkik olmakla birlikte 1,5 Tesla (T) ya da 3 T cihazlarla uygulanan multi-parametrik MRG (MpMRG), tanıda vazgeçilmez bir tetkik haline gelmiştir. Bu çalışmada; prostat kanseri şüphesiyle 1,5 T cihaz ile MpMRG yapılan hastaların, Prostat Görüntüleme Raporlama ve Bilgi Sistemi versiyon2 (PI-RADSv2) skorlarını, prostat biyopsisi patoloji sonuçlarıyla karşılaştırmayı amaçladık.

Yöntem ve Gereçler: Çalışmamıza kliniğimizde Ocak 2017-Ocak 2020 tarihleri arasında prostat kanser şüphesi nedeniyle MpMRG ve ardından prostat biyopsisi yapılmış 52 hasta (26 benign, 26 malign) dahil edildi. Bu olguların yaşı, prostat hacmi, kan PSA (prostat spesifik antijen) değeri, yoğunluğu ve patoloji sonuçları analiz edildi. Deneyimli bir radyolog tarafından her bir hasta için PI-RADSv2 skorlama sistemine göre kategorizasyon yapıldı. İstatistiksel analizde "Ki kare" testi ile "Student-t" test kullanıldı.

Bulgular: Benign hasta grubunun (96,4±77,7) ortalama prostat hacmi malign gruptan (47,4±17.3) anlamlı olarak daha yüksektir (p=0,003). Ortalama PSA değeri ve yoğunluğu malign hastalarda (PSA değeri, 13,7±16,5 ng/ml; PSA yoğunluğu, 0,33±0,46 ng/ml/cc) benign hasta grubundan (PSA değeri, 6,8±3,3 ng/ml; PSA yoğunluğu, 0,09±0,05 ng/ml/cc; p<0,05) daha yüksektir. 1,5T cihaz ile uygulanan MpMRG'nin anlamlı prostat kanseri saptamadaki sensitivitesi %73,08, spesifitesi %84,62 pozitif prediktif değeri %82,61 iken negatif prediktif değeri ise %75,86 olarak hesaplandı.

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Tartışma ve Sonuç: PI-RADSv2'ye göre negatif MpMRG'nin yüksek negatif prediktif değeri göz önüne alındığında MRG gereksiz biyopsi oranını azaltabilir.

Anahtar Kelimeler: Multi-parametrik manyetik rezonans görüntüleme, prostat biyopsisi, prostat kanseri, Prostat Görüntüleme Raporlama ve Bilgi Sistemi versiyon2

Introduction

Prostate cancer is the most frequently diagnosed disease among men worldwide [1]. It is the second most frequent cause of deaths due to malignant tumors [2]. Digital rectal examination (DRE) and prostate-specific antigen (PSA) are used in prostate cancer screening [3]. Prostate biopsy continues to be the gold standard diagnostic technique for the detection of prostate cancer. However, some patients are subjected to unnecessary biopsies because of false-positive results. Even though clinically insignificant cancers can be detected with biopsy, clinically significant cancers are sometimes missed. Furthermore, trans-rectal ultrasound (TRUS) biopsy may carry significant morbidity and cause life-threatening sepsis [4]. In recent prospective studies, the sensitivity of prostate biopsy in the diagnosis of cancer was reported to be 70% [1]. For this reason, non-invasive tests that will reduce unnecessary biopsies by predicting negative results are considerable [5]. In recent years, magnetic resonance imaging (MRI) has stood out as a non-invasive technique that can be used for the evaluation of the prostate and its surrounding tissues. Initially, prostate MRI was based on morphologic assessment using T1-weighted (T1W) and T2-weighted (T2W) images. It had limited capability to distinguish benign pathological tissue and clinically insignificant prostate cancer from clinically significant cancer. To enhance diagnostic accuracy, anatomic T2W was combined with functional sequences including diffusion-weighted imaging (DWI), dynamic contrast-enhanced (DCE) MRI, and MR proton spectroscopy under the title of multiparametric MRI (MpMRI). For standardization of evaluation and reporting in prostate MpMRI examinations, a scoring system called the Prostate Imaging Reporting and Data System (PI-RADS) was developed in 2012, which demonstrates the cancer risk probability and aggressiveness obtained by multiparametric (morphological-functional) examination of the prostate. The PI-RADS scoring system was revised as PI-RADSv2 in 2015. In PI-RADSv2, the dominant technique was defined based on lesion location. Accordingly, DWI was defined as the dominant technique in the evaluation of peripheral zone lesions and T2W images as the dominant technique in the evaluation of transitional zone lesions. A simplified interpretation of DCE-MRI evaluation was added. According to that, an area of rapid enhancement matching an abnormality in DWI or T2W sequences was considered positive or negative on the basis of qualitative evaluation. MR spectroscopic examination is no longer used in the PI-RADSv2 system [6]. The likelihood of the presence of prostate cancer was determined based on an overall combination of the results obtained from T2W, DWI, and DCE-MRI using a 5-point "Likert" scale (1: very low level of suspicion; 2: low level of suspicion; 3: equivocal; 4: cancer probable; 5: definitely cancer) [7]. In PI-RADSv2, clinically significant cancer was defined as cancers meeting the criteria of Gleason pattern of ≥ 4 and/or cancer core length of ≥ 6 mm and/or tumour volume of ≥ 0.5 cc and/or extra-prostatic spread. This definition aims to standardize the reporting of MpMRI and the correlation with pathology for clinical and research applications [6,8].

In this study, the PI-RADSv2 scores of the patients who underwent 1.5 Tesla MpMRI for suspected prostate cancer in our clinic were compared with the results of the prostate

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biopsies performed under TRUS, and the literature was reviewed. The diagnostic performance of 1.5 Tesla MpMRI was evaluated in cancer diagnosis.

Material and Method

Our retrospective study was approved by the Institutional Review Board of 'Dr. Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital' (Decision number and date: 2021-04/1096 and 21.04.2021). We retrospectively analysed a total of 245 MpMRI obtained in our hospital between January 2017 and January 2020. Patients who did not have histopathological results and those who were diagnosed with prostate cancer after prostate biopsy prior to MRI were excluded from the study. As a result, 93 patients (67 benign, 26 malignant) who underwent cognitive prostate biopsy along with MpMRI and TRUS due to a total PSA value of 4 ng/ml and/or suspicious findings in DRE were included in the study. To be able to make a comparison between the groups which included 67 benign pathologies and 26 malignant pathologies, the number of patients in the groups were equalized. In line with this purpose, 26 benign patients were selected from the group consisting of 67 benign patients by simple random sampling method and as a result, 26 malignant and 26 benign patients were included in the study. Age, prostate volume, the value and density of blood PSA were recorded for these patients. The examination was performed with 1.5 Tesla MRI (GE Optima 360) using an 8-channel torso coil. In the protocol, 3 plans were included: T2W, DCE-MRI and DWI. The DWIs were obtained on b=50, 1000 and 1400. Scoring was carried out according to the PI-RADSv2 scoring system by a 12-year experienced radiologist. As a result of histopathological evaluation, Gleason grades were recorded for the cases with prostate carcinoma. MpMRI results were considered clinically significant but negative for cancer for PI-RADS 1 and 2 lesions, whereas they were regarded positive for PI-RADS 3, 4, 5 lesions. Statistical analyses were performed using the SPSS (version 22.0, SPSS). The Kolmogorov-Smirnov test was used to analyze the normal distribution of data. Continuous variables were presented as mean ± standard deviation. Patients were compared in terms of differences in age, total PSA value, PSA density and the mean prostate volume using the "Student T" test. Categorical variables were described as numbers and percentages, and tested by Chi-square test. The "p" value less than 0.05 was considered to show a significant difference. The parameters of diagnostic accuracy including sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated with corresponding 95% confidence intervals.

Results

There was no statistically significant difference between the two groups regarding the mean age with the mean age of the malignant patient group being 65.7±8.7 years and the mean age of the benign patient group being 61.6±6.5 years (p=0.064). The mean prostate volume of the benign patient group was significantly higher compared to the malignant group (p=0.003). While the mean total PSA of the malignant patient group was 13.7±16.5 ng/ml, the mean total PSA of the benign patient group was 6.8±3.3 ng/ml. The mean total PSA of the malignant group was significantly higher than that of the benign group (p=0.041). The mean PSA density of the malignant patient group was 0.33±0.46 ng/ml/cc, whereas that of the benign patient group was 0.09±0.05 ng/ml/cc. The mean PSA density of the malignant group was

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Table 1: The comparison of patient characteristics between benign and malignant groups

	Benign patients (n = 26)	Malignant patients (n = 26)	P value
Age (mean±SD)	61,6±6,5	65,7± 8.7	0,064
Prostate volume (mean±SD)	96,4±77,7	47,4±17,3	0,003
Total PSA value (ng/ml) (mean±SD)	6,8±3,3	13,7±16,5	0,041
PSA density (ng/ml/cc) (mean±SD)	0,09±0,05	0,33±0,46	0,013

SD, standard deviation; PSA, prostate spesific antigen; n, number of cases.

Table 2. PI-RADS v2 scores of patients due to histopathologic results

PI-RADS v2 score	Histopathologic Results Benign patient group (n = 26)	Malignant patient group (n = 26)
PI-RADS 2	22	7
PI-RADS 3	4	6
PI-RADS 4	0	7
PI-RADS 5	0	6

n, number of cases; PI-RADSv2; Prostate Imaging Reporting and Data System version 2

Table 3: Diagnostic performance of multi-parametric MRI

	Results
Sensitivity	73.08%
Specificity	84.62%
Positive predictive value	82.61%
Negative predictive value	75.86%
Accuracy	78.85%

significantly higher as compared to the benign group (p=0.013). Table 1 shows the differences between the variables.

Table 2 shows the PI-RADSv2 scores of the malignant and benign groups obtained with MpMRI. The benign patient group was scored as PI-RADS 2 (n=22) and PI-RADS 3 (n=4) according to MpMRI. On the other hand, the malignant patient group was scored as PI-RADS 2 (n=7), PI-RADS 3 (n=6), PI-RADS 4 (n=7) and PI-RADS 5 (n=6) according to MpMRI. 19 of 26 malignant patients scored ≥3 in PI-RADS (Table 2). It was indicated that MpMRI had a sensitivity of 73.08% and a specificity of 84.62% in the diagnosis of prostate cancer. (Table 3). In cases with suspected prostate cancer, the PPV of the PI-RADSv2 score reported as a result of MpMRI was 82.61%, while its NPV was calculated as 75.86% (Table 3). The accuracy rate was found to be 78.85%. Figure 1 shows PI-RADSv2 categories by the Gleason score of the cases. Half of the cases (4/8) was scored as PI-RADS 2 in Gleason 3+3. In Gleason 4+3, however, half of the cases (3/6) was scored as PI-RADS 4 while the other half (3/6) was scored as PI-RADS 5.

Discussion

In this study, the PI-RADS scores of patients who underwent MpMRI with 1.5 Tesla for suspected prostate cancer in our clinic were retrospectively compared with the results of TRUS-guided prostate biopsies. The mean age, mean PSA value, mean PSA density, and prostate volumes of the patients were analysed. The diagnostic performance of MpMRI in the diagnosis of clinically significant cancer was evaluated.

In our study, the mean total PSA value and the mean PSA density of the malignant patient group were significantly higher compared to the benign patient group (p=0.013). It was demonstrated in the study by Shakir et al. that targeted biopsy with MRI increases diagnostic accuracy in patients with high PSA values [9].

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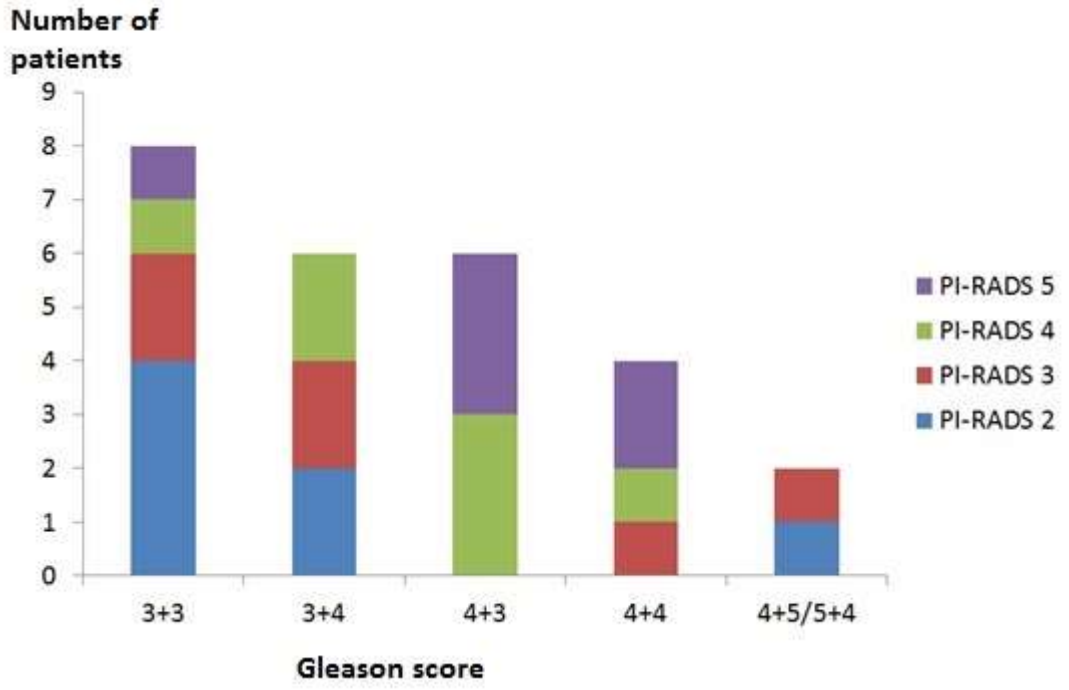


Figure1: Gleason scores of patients due to PI-RADSv2 category

In Shakir et al., the rate of diagnosed clinically significant prostate cancer was 56.2% in 1003 patients who underwent targeted and 12-quadrant TRUS-guided biopsies. In comparison with 12-quadrant systematic biopsy, targeted biopsy was able to detect a higher rate of clinically significant cancer. Furthermore, this diagnostic accuracy rate increased even more in patient groups with PSA values between 4 and 10 ng/ml and in those with PSA values >10 ng/ml. It was demonstrated that in patients with a total PSA of ≥ 5.2 ng/ml, targeted biopsy increases the accuracy of clinically significant prostate cancer diagnosis compared to conventional biopsy. In this study, we found the mean total PSA value as 13.7±16.5 ng/ml in malignant patients. In our study, the accuracy of TRUS biopsy is higher compared to the study conducted by Shakir et al. [9]. However, this may be due to the fact that there was a small number of patients in our study and that we did not make comparisons by dividing patients into subgroups according to PSA values.

In our study, we evaluated the accuracy of MpMRI in the diagnosis of clinically significant prostate cancer. As a result of histopathological examination, cognitive biopsy performed after MpMRI with 1.5 T torso coil to detect significant prostate cancer had a sensitivity of 73.08%, a specificity of 84.62%, a PPV of 82.6%, and a NPV of 75.86% with an accuracy rate of 78.85%. As Tamada et al. found in their retrospective study conducted on 50 patients with a total PSA value ranging from 4-10 ng/ml that MpMRI performed with 1.5 T had a sensitivity of 83%, a specificity of 80%, PPV of 91%, and NPV of 67%, and an accuracy rate of 82% in the diagnosis of prostate cancer similar to our results [10]. In the study Tanimoto et al. retrospectively investigated 83 patients with high PSA values using a 1.5 T system, the sensitivity, specificity and accuracy rate of MpMRI were found to be 95%, 74% and 86%, respectively [11]. Compared to our study, the diagnostic performance of MpMRI was higher than the study of Tanimoto et al. [11]. Although there are some minor differences in the diagnostic performance of MRI among the studies performed with a 1.5 T MRI device in the literature, MpMRI is a non-invasive technique

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with high accuracy rates in the diagnosis of prostate cancer as stated in our study.

Sertdemir et al. reported that prostate cancer could be better distinguished from chronic prostatitis at 3 T MRI compared with 1.5 T MRI [12]. Another study in which Ulrich et al. made a comparison between 1.5 T MRI and 3 T MRI revealed that the signal-to-noise ratio (SNR) and the contrast-to-noise ratio (CNR) were similar in T2W images at both magnetic field strengths (p=0.7-1); however, SNR and CNR were significantly lower in DWIs obtained with 1.5 T MRI compared to 3 T MRI (p<0.01) [13]. When DWI is important in the evaluation of clinically significant cancers in the peripheral zone, 3 T MRI may be preferred. Using a 1.5 T device may have affected the sensitivity and specificity in our study, leading to relatively lower accuracy rates compared to previous studies with 3 T.

Our study has some limitations that should be noted. Our study was designed with a retrospective design. Performing TRUS-guided cognitive biopsy in MpMRI instead of using MRI-guided in-bore biopsy or MRI/TRUS fusion-guided biopsy for lesions suspected to have cancer may have affected our accuracy rates. Recent studies have demonstrated that compared to systematic biopsy, MRI-guided biopsy improves diagnostic performance in detecting clinically significant cancers [14]. Furthermore, although anterior prostate cancer represents a considerable part of all prostate cancer types, systematic TRUS biopsy may be insufficient in the diagnosis of such lesions. Turkbey et al. reported that anterior prostate cancer could be detected higher in fusion biopsy as compared to systematic TRUS biopsy [15]. Moreover, it was revealed that MRI and subsequent MRI/US-fusion biopsy increased the diagnosis rate of lesions that were missed by systematic biopsy [9, 15]. Another limitation is that as the measurements were carried out by a single radiologist, we were not able to conduct an analysis for inter-observer agreement. To evaluate the diagnostic performance of 1.5 T MpMRI, it is necessary to conduct studies on larger patient groups that include risk factors.

Conclusion

This study demonstrated the ability of 1.5 T MpMRI performed in our institution to predict the results of TRUS biopsy. Even though our results have lower accuracy rates compared to the studies performed with 3 T MRI in the literature, it can be concluded considering the high NPV of 1.5 T MRI in our study that MpMRI can prevent unnecessary biopsy in patients with high PSA. Performing biopsy for the suspicious area determined by MpMRI in patients with high PSA will increase biopsy performance and diagnostic accuracy.

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