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ORIGINAL ARTICLE

Accuracy of T2 And DW-MRI According To PI-RADS-V2 In Discriminating Clinically Significant Prostatic Nodule:

A Comparative Study

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ABSTRACT

Background: MRI is widely used now in prostatic lesions for guiding the diagnostic sample, staging and for active surveillance. Despite the widespread use of MRI, the variability in performing prostate MRI across practices remains challenging. PI-RADS has increasingly become an important part of prostate cancer diagnostics.

Methods: We aimed to compare the accuracy of using T2 and DW-MRI separately in discriminating prostatic nodule and compare them when using total PIRADS according to PI-RADS-v2 using mp-MRI at 1.5. A prospective study included 120 male patients with clinically suspected prostate cancer due to raised prostate-specific antigen (PSA) levels and/or suspicious prostatic lesion during digital rectal examination (DRE**)**.In each prostate lesion, PI-RADS score (from 1 - 5) was given for each prostatic nodule according to T2-WI, then according to DWI. Finally, we reported the overall PI-RADS score of each patient according to V2**.**

Results: The validity of T2WI imaging alone in diagnosis of prostate cancer was 88.5% sensitivity, 72 % specificity, 81.6% accuracy, 81.5 % predictive value of positivity (PVP) and 81.8% predictive value of negativity (PVN). The validity of DWI imaging was 90% sensitivity, 70% specificity, 81.6% accuracy, 80.7 % PVP and 83.3 % PVN. Total PIRADS v2 scoring revealed an increase in Sensitivity, Specificity, Accuracy, PVP and PVN in diagnosis of prostatic focal lesions reaching 94.2 %, 76 %, 86.6%, 84.6% and 90.4 % respectively

Conclusions: T2WI and DWI have nearly similar accuracy in discriminating benign and malignant prostatic lesions with considerable raising in the accuracy when using total PIRAD V2 in diagnosing peripheral and transitional zones prostatic lesions.

Key words: Cancer prostate, MpMRI, PI-RADs v2

INTRODUCTION

In elderly men, prostate cancer is documented as the 2nd most common malignancy and the most common cause for cancer-related mortality [1- 2].
The first diagnostic tools for cancer prostate areserum prostate-specific antigen (PSA) level and DRE, which are insufficient and inaccurate for risk stratification andhave suboptimal accuracy for the early detection [3].The European Society of Uroradiology and The American College of Radiology introduced Prostate Imaging–Reporting and Data System (version 1) and its update version 2 (PI-RDAS-v2) as a new diagnostic tools that can detect, localize and also help in sampling the prostatic lesions [4].

The PI-RADS-v2 is introduced to increase the recognition and categorization of risk stratification in patients with suspected prostatic malignancy, as well as, standardizes the diagnosis and reporting of prostate cancer (PCa) [5]. PI-RADS scoring system is used now in the management of PCa, which has highlighted the clinical application of prostate mp-MRI [6-8]**.**
The main purpose of these PIRADS is building a uniform technical standard for prostate multi planner-MRI, making it simple and clear with different reporting terms. It also generates assessment groups that summarizes ranks of risk probability that could help in selecting and preparing the patients for the next line in the

management plane and lastly enhances inter-disciplinary communications with clinicians [6].

The purpose of our study was to assess the accuracy of T2 & DW-RMI separately in characterization of both benign and malignant prostatic nodules then compare them with Total PIRADS according to PI-RADS-v2 using mp-MRI at 1.5 Tesla machine.

METHODS

Study population

This cohort prospective study was carried out from April 2019 till October2021, included 120 male patients with clinically suspected prostate cancer due to abnormally elevated prostatic-specific antigen (PSA) blood levels and /or patients with abnormal DRE.

Written informed consent was obtained from all participants, the study was approved by the research ethical committee of Faculty of Medicine, Zagazig University (IRB No. 5306, 19-5-2019). The study was done according to The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Inclusion criteria

Patients with clinically suspected malignant prostatic lesion even due to abnormal DRE or high serum PSA level (> 4 ng/ dl) or both were included.

Exclusion criteria

Patients contraindicated to do MRI. Patients refused contrast media injection. Patients with unavailable pathological results. Patients previously proved as cancer prostate and received palliative (chemotherapy, radiotherapy, or hormonal) therapy or underwent biopsy prior to our MRI.

MR imaging technique

Multi planner-MRI was performed at a 1.5T machine (Philips, Achiva, 16 phased array body coil). The examination technique includes T2-weighted FSE imaging (TR/TE = 6000/ 102 ms, matrix = 256 × 192; FOV= 140mm; intersection gap= 1 mm slice thickness= 3 mm. DWI was done at different b values (800, 1000, 1200 s/mm2), as follows: free-breathing spin-echo EPI (TR/TE = 3000/90 ms; slice thickness ≤ 4 mm; no gap; in-plane dimension: less than or equal 2.5 mm phase and frequency; FOV 24 cm. ADC maps developed from the least and highest b value ("50–100 s/mm2" and 800–1200 s/mm2 respectively). ADC values of the lesions were measured by placing regions of interest (ROIs) centrally on the lesion when occupying ≥ 50% of the lesion using circle shaped ROI (r=10mm).Axial T1WI images done using a fast spin-echo sequence (TR/TE = 7.4/675 ms; slice thickness 3 mm; intersection gap, 1 mm; matrix size, 256 × 160; FOV, 140 mm; the number of signals acquired, 2). CE-MRI T1 mp MRI were achieved by IV injection of contrast (Dotarim, 0.5 mmol/ml) in dose of 0.1 ml/kg BW).There were 26 lesions at the PZ classified as PI-RADs 3 according to their diffusivity pattern on DWI, only those 26 cases underwent contrast enhanced MRI.

Image analysis

Images were analyzed by two radiologists with 5 to 10 years of experience in prostate MRI, they were not told about the clinical findings and pathological diagnosis.

Each lesion was assigned a score from 1 to 5 indicating the likelihood of clinically significant cancer:

- PI-RADS 1: very low (clinically significant cancer is highly unlikely to be present)
- PI-RADS 2: low (clinically significant cancer is unlikely to be present)
- PI-RADS 3: intermediate (the presence of clinically significant cancer is equivocal)
- PI-RADS 4: high (clinically significant cancer is likely to be present)
- PI-RADS 5: very high (clinically significant cancer is highly likely to be present)
- PI-RADS X: component of exam technically inadequate or not performed

They excluded hemorrhage through reviewing the axial T1WI. They evaluated the TZ onT2-WI to assess the presence of suspicious morphological changes or benign prostatic hyperplasia (BPH). The PZ was assessed on T2-WI also, to reveal the morphological feature for each suspected lesion. For PZ lesion, DWI was the cornerstone and any lesion with restricted diffusion was reported (bright signal on DWI and low signal on its corresponding ADC map). Also, TZ-suspicious lesions were analyzed on DWI if they were restricted or not. The binary positive or negative contrast enhanced MRI criteria have been clarified, considered positive if it is focal and occurs earlier than adjacent normal prostatic tissues and considered negative if no early or simultaneous enhancement is noted. Each case was reported, and PI-RADS from 1 to 5 was scored according to DWI and according to T2-WI separately, then the total PI-RADS score for each case was reported (Fig 1).

Pathologic analysis

For all MRI doubtful prostatic nodules in our study, TRUS guided biopsy were taken by 10 years expert radiologist. Ten–12 systematic core prostate biopsies were taken. Directed biopsies are

obtained from any area that is considered suggestive on the basis of MRI findings using A high frequency transrectal transducer (6.5 - 9 MHZ) with a condom cover. The use of at least two imaging planes allows visualization of the prostate in three dimensions permitting more accurate localization of abnormalities and extent of the lesion. Samples had fixed in formalin and then underwent comprehensive histopathologic assessment. According to biopsy results, the grading score of each case was ranged according to Gleason score.

Statistical analysis

Analysis of data was performed by IBMSPSS software (package version 20.0).The diagnostic value of PI-RADS scoring system evaluated through construction of two-by-two contingency tables with the determinate classification of lesions into benign or malignant by biopsy which considered as the gold-standard in our study. Different diagnostic indices then calculated: sensitivity, specificity, predictive value of positivity and predictive value of negativity.

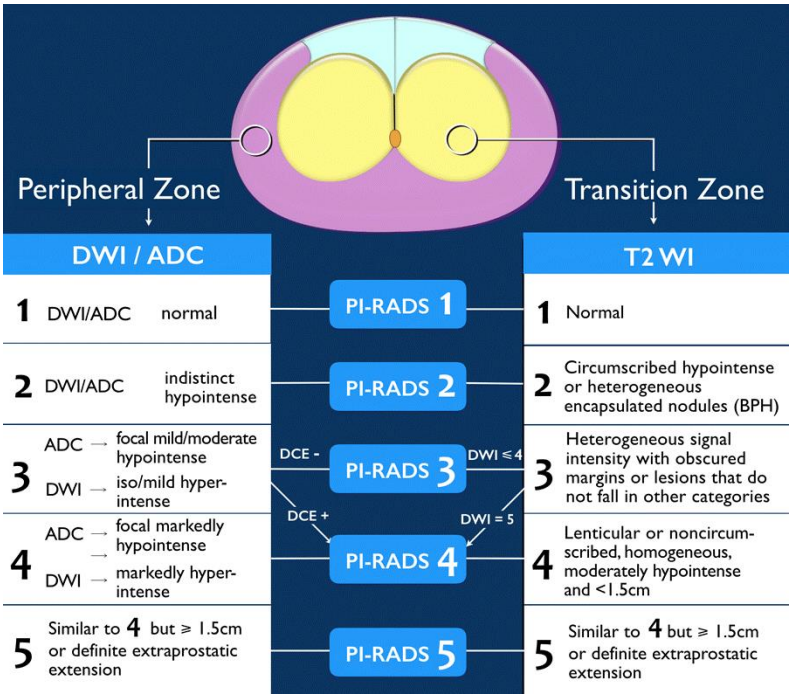


Figure 1: PI-RADS from 1 to 5 scored according to DWI and according to T2-WI separately, then the total PI-RADS score is calculated.

RESULTS

This study included 120 patients, their age ranged from 45 to 80 years (their mean age ± SD 65 ± 8 years).After TRUS guided biopsy pathological results; 50 samples proved to be negative representing 41.7% of the total samples and the other 70 lesionswere positive representing 58.3%. According to Gleason score;the grading score of the cases ranged from 3+3 to 4+5 ***(table 1)***.

Out of the 70 pathologically proved malignant lesions, 60lesions(85.7%) were located in the PZ (Fig 2) and 10lesions (14.3%) were located in the TZ (fig 3). The remaining 50 lesions were pathologically proved to be benign: 38 cases were benign prostatic hypertrophy and 12 cases were prostatitis (one case complicated with abscess fig 4). Out of the 50 benign lesion: 36 lesions (72%) were located at the TZ (Fig 5)and 14 lesions (28%) located at the PZ.

All 120 suspicious prostatic lesions underwent mp-MRI and ***according to their signal on T2WIs***they were given a score on PI-RADs V2.Forty-four lesions were considered of high probability to be benign (score 1-2) and 38lesions were considered of high probability to be malignant(score 4-5)**.** The indeterminate lesions on T2WI were 38 lesions (score 3)**.**

Histopathology proved that malignant lesions (70 cases) were scored according to T2 PIRADS score as follow: 31 lesions (score4-5), 8 lesions (score 1-2) and 31 lesions (score 3)and the pathologically proven benign lesions (50 cases) were scored according to T2 PIRADS score as follow: 36 lesions (score 1-2), 7 lesions score (4-5) and 7 lesions (score 3) ***(T*able 2).**

Then all 120 suspicious prostatic lesions were analyzed ***regarding their diffusivity on DWI and given a score on PI-RADs V2.***Forty four lesions were considered probably malignant (score 4-5), 42 lesions probably benign (score 1-2)and the last 34 lesions (score 3) were considered indeterminate according to DWI signals.

Histopathology proved that, malignant lesions (70 cases) were scored according to DWI-PIRADS score as follow: 39 lesions (score 4-5) and 7 lesions (score 1-2). The pathologically proven benign lesions (50 cases) were scored according to DWI-PIRADS score as follow: 35 lesions (score 1-2) and 5 lesions (score 4-5). The remaining 34 cases were indeterminate on DWIs (score 3), and their final pathological diagnosis was malignant in 24 lesions and benign in 10 lesions (**table 2).**

From the indeterminate 34 lesions according to DWI; only 26 cases were in the PZ, so they underwent contrast enhanced MRI, as a secondary sequence for lesionsin PZ only according to the PIRADs V2. Contrast enhanced MRI up graded the PIRADS to score 4 in 20 lesions as they showed immediate early focal enhancement. The remaining 6 lesions with PI-RADS 3 score revealed negative enhancement (No enhancement in 4 cases and simultaneous enhancement to the rest of the prostatic gland in 2 cases)so still scored as PI-RADS 3.

In applying thetotal PI-RADS mp-MRI for the 120 suspicious prostatic lesions, 64 lesions were probably malignant (score 4-5), and 42 lesions were probably benign (score 1-2), whilethe indeterminate lesion on total PI-RADs v2 score were only 14 cases.Histopathology proved malignant nodule in 62 lesions (scored as 4-5) and 4 lesions (scored as 1-2) While pathologically proved benign lesions were: 2 lesions (scored 4-5) and 38 lesions (scored 1-2). Regarding total PI-RADS, the indeterminate 14 lesions proved pathologically to be malignant in 4 lesions and benign in 10 lesions, ***(Table 2).***

The accuracy of T2WI, DWI & total PI-RADs in differentiating benign & malignant prostatic lesions were compared in ***table 3.***

Table 1: Frequency distribution of the studied patients according to Gleason score.

Tumor Gleason score at TRUS biopsy	No of lesions	Percentage (%)
3+3	4	5.7 %
3+4	12	17.1%
4+3	20	28.7%
4+4	30	42.8
4+5	4	5.7 %
Total	**70**	**100%**

Table 2: Validity of PI-RADs T2WI, PI-RADs DWI, and total PI-RADs scoring system regarding the histopathology

PI-RAD T2WI score	**Benign (n=50)**	**Malignant (n=70)**	**P value**
<3 (n=44)	36	8	**<0.001***
3-5 (n=76)	14	62	
PI-RAD DWI score	**Benign (n=50)**	**Malignant (n=70)**	**P value**
<3 (n=42)	35	7	**<0.001***
3-5 (n=78)	15	63	
Total PI-RAD score	**Benign (n=50)**	**Malignant (n=70)**	**P value**
<3 (n=42)	38	4	**<0.001***
3-5 (n=78)	12	66	

Table 3: Summary of the validity of T2WI, DWI & total PI-RADs in discriminating benign & malignant prostatic lesions.

Variables	**T2 PI-RADs**	**DWI PI-RADs**	**Total PI-RADs**
Sensitivity	**88.5%**	**90%**	**94.2%**
Specificity	**72%**	**70%**	**76%**
Accuracy	**81.6%**	**81.6%**	**86.6%**
PVP	**81.5%**	**80.7%**	**84.6%**

PVN	**81.8%**	**83.3%**	**90.4%**

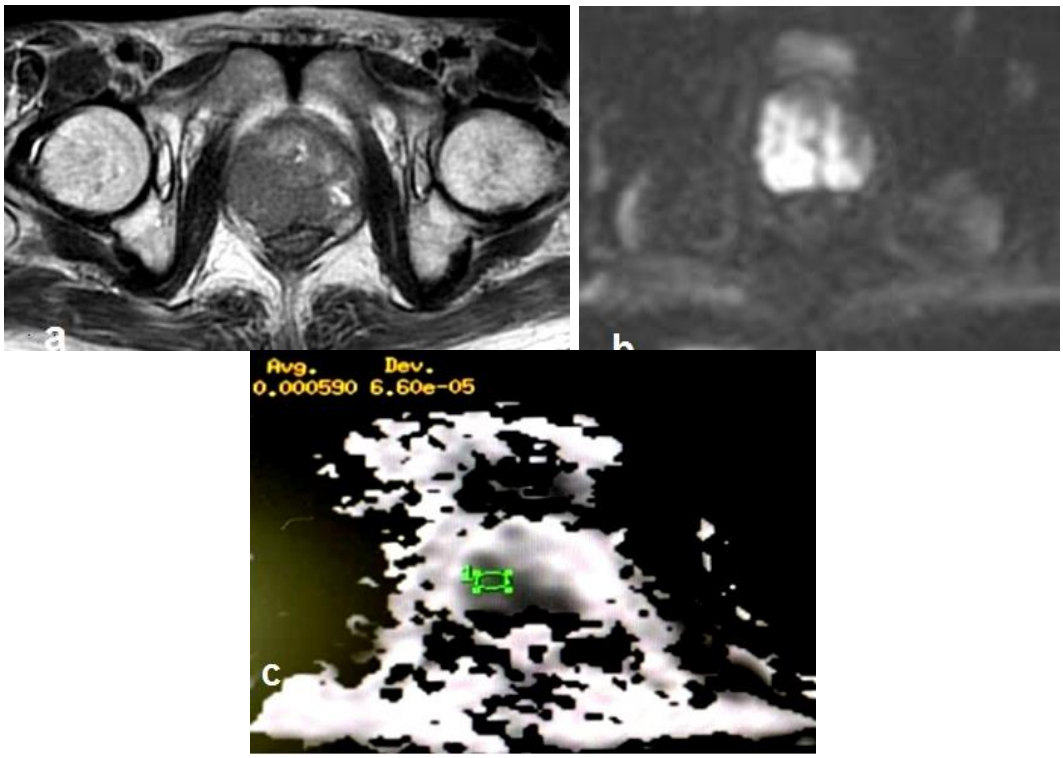


Figure 1: Gleason score 4 + 4 prostatic adenocarcinoma. A- Axial T2WI shows well-defined homogeneous hypointense mass > 15 mm seen in the RT posterolateral PZ of the prostate. B- Axial DWI(b=1200s^2/mm) shows focal hyperintense mass more than 15mm.C- Axial corresponding ADC map shows diffusion restriction with ADC value (0.59 x 10-3 mm2/s).
(Total PI-RADS score was 5).

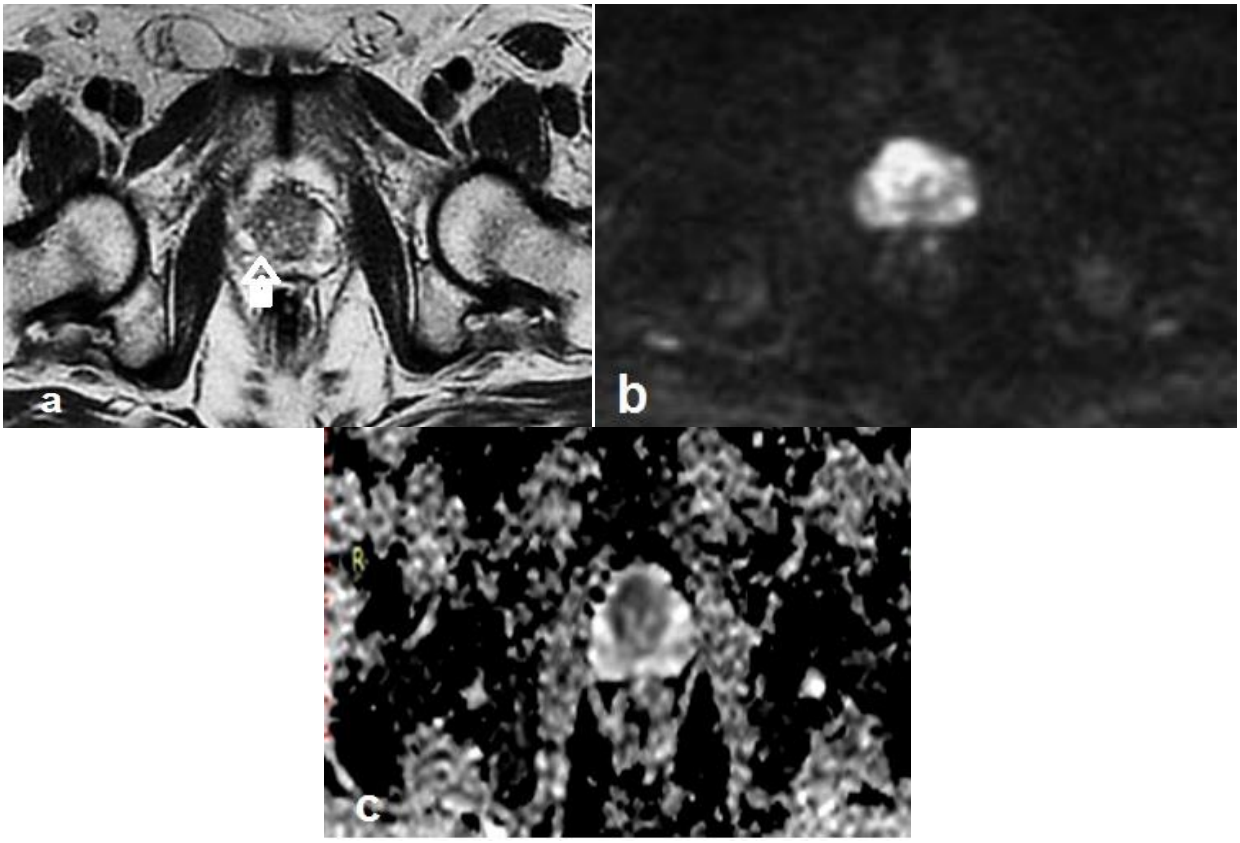


Figure 2: Gleason score 4 + 3 prostatic adenocarcinoma. A- Axial T2WI shows well-defined homogeneous hypointense mass > 15 mm seen in the TZ(arrow). B- Axial DWI (b=1200s^2/mm)shows focal hyperintense mass more than 15 mm. C- Axial corresponding ADC map shows restricted diffusion.
(Total PI-RADS score was 5).

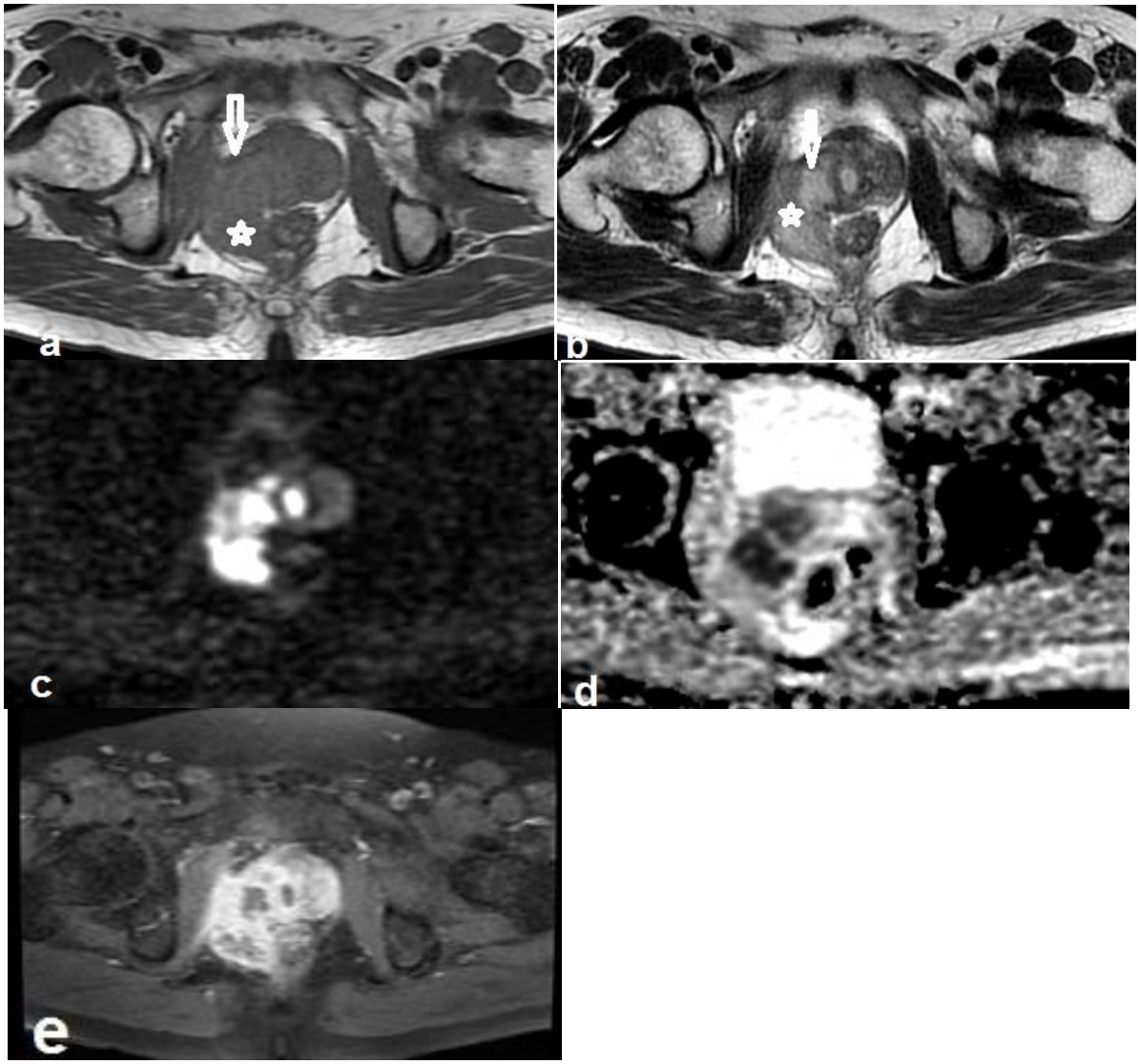
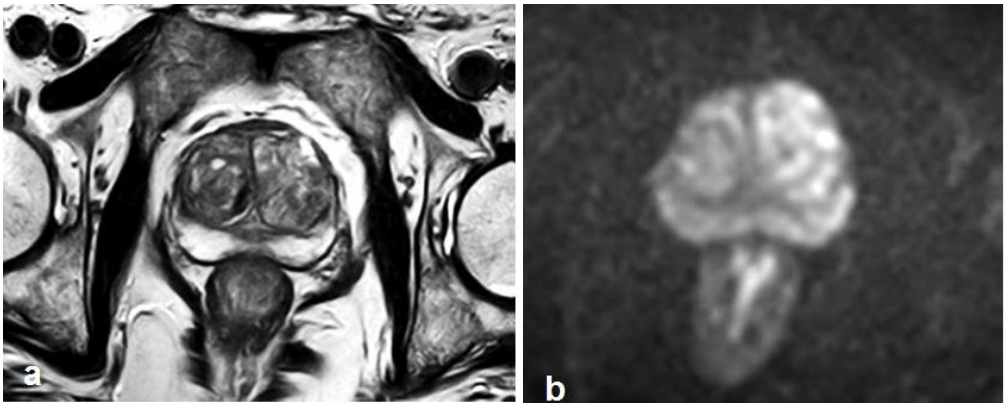


Figure 3: Prostatic abscess. A-Axial T1WI shows illdefined hypointense lesion involving the RT posterolateral peripheral zone of prostate*(arrow)* and extending posteriorly to the right mesorectal fat*(astrix).* B-Axial T2WI shows hyperintense signal of the lesions C- Axial high b value DWI & D-Axial ADC show central restricted diffusionwith facilitated margins. E-Contrast enhanced MRI shows marginal and heterogenous moderate enhancement (Total PI-RADS score was2).



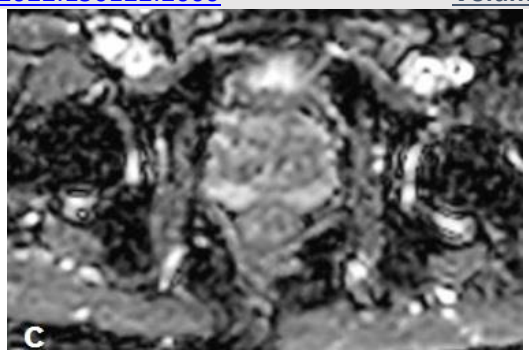


Figure 4: Benign Prostatic Hyperplasia (BPH). (A) Axial T2WI shows circumscribed heterogeneous encapsulated nodules at the TZ . (B) Axial DWI shows isointense to mildly hyperintense signal on high b value =1200s^2/mm. (C) Axial ADC map shows indistinct hypointense nodules
(Total PI-RADS score was 2)

DISCUSSION

Multiparametric MRI (mp-MRI)is considered now, as the imaging modality of choice for the diagnosis of prostate cancer. In the setting of primary diagnosis, prostate MRI is interpreted according to the PI-RADS score [9].

Our study included 120 patients with suspicious prostatic lesion, We aimed to compare the accuracy of using T2 and DW-MRI separately in discriminating prostatic nodule and compare them when using total PIRADS according to PI-RADS-v2 using mp-MRI at 1.5and TRUS guided biopsy results as a gold standard.

The histopathology revealed 70 malignant ‘‘adenocarcinoma” and 50 benign lesions (38 benign prostatic hypertrophy, 12 prostatitis (one case complicated with abscess) with mean PSA was 53.3 ± 33.3 ng/dl among 70 malignant cases& mean PSA among 50 benign cases was 10.7 ± 7.7 ng/dl. According to the grading Gleason score of the patients, the most common score was 4+4(42.8%) then 4+3(28.5 %).

First, we assessed the validity of T2WI imaging in diagnosis of PC, which reached: 88.5% sensitivity, 72 % specificity, 81.6% accuracy, 81.5 % predictive value of positivity (PVP) and 81.8% predictive value of negativity (PVN).

The accuracy, sensitivity, specificity and PVP of T2WI in our study were matched with those of **Kim et al:** (79.4 %), (78%**)**, (77 %) and (89.4 %) respectively [**10],** **however**, **Kitajima et al.**reported higher specificity of T2 alone reaching 91.4% as they used 3T MRImachine and this is reflect the importance of T2 sequence in diagnosis of prostatic lesions, but less PVP at 68.2%, may be due to sample bias as they used fewer cases [**11].**

Second,we assessed the validity of DWI imaging in diagnosis of PC, which reached: 90% sensitivity, 81.6% accuracy, 80.7 % PVP and 83.3 % PVN. These were comparable with the results of Kim et al which were 90.7 % , 80.5 % ,81.4% ,80.2 % respectively **but** our DWI specificity was 70% lower than that of Kim et al specificity 77.8 % **[10]**. The slight higher specificity reported by Kim et al., may be due to using of MRI-Ultrasound fusion biopsy for accurate targetting of the biopsy, whoever it is not available in our institute.

In our study the mean ADC value for malignant pprostatic nodule was 0.59 x 10^{-3}± 0.14 x 10^{-3} mm^2/s. The ADC of benign prostatic noduleswas 1.45 x 10^{-3}± 0.24 x 10^{-3} mm^2/s, which was statistically significantly higher than that of malignant nodules (P < 0.001).These results were matched with Koo et al. 2013 and Meyer et al.,2020,who revealed that; normal prostate parenchyma and prostate cancer have a significant difference regarding ADC values [**12-13]**.

We found that the validity of ADC values in diagnosis of PCwas, 92.3% specificity ,94.1 % PVP and 92.3 % PVN in our study that was comparable with results of **Zidan and Tantawy** who reported specificity,PVP , PVN at 94.1 %, 91.7 % , 88.9 % respectively but the sensitivity of our study (94.1%) was higher than them (84.6%) **[14]**. This higher sensitivity may be due to larger sample size in our study.

In PI-RADS V2, peripheral zone nodules scored as PI-RADAs 3 regarding their DWI signals underwent DCE-MRIas a secondary sequence. Then according to their pattern of enhancementthey were upgraded to PI-RADS 4 or kept as PI-RADS 3. DCE-MRI in our study raised the sensitivity and accuracy to 93.2 % and 90.4 % respectively which were concordant with Sorial et al **[15].**

Our total PIRADS scoring results using new PI-RADs v2 scoring system revealed that Sensitivity, Specificity, Accuracy, PVP, PVN of mp-MRI in diagnosis of PC were: 94.2 %, 76 %, 86.6%, 84.6% and 90.4 % respectively.

Our sensitivity of total PIRAD score result was concordant with many previous studies as; Daniel

et al who influenced the PI-RAD score as a reliable tool for cancer detection with a sensitivity reached 90% [**16]**. Also, Alistair et al. with sensitivity 97 %**(17)**, **Gatti et al** with sensitivity 96% [**(18] as well as, El-kareem et al & Dola et al.**, whom sensitivity reached92.11% & 88.04% respectively. This reflects the importance of PIRADS V2 in detection cancer prostate and its applicability [**19-** 20].

Also our Specificity and accuracy results were comparable with results of **Han et al., 2020** who reported that Specificity and Accuracy of PI-RADS in diagnosis of prostatic lesions were 80.2 % and 81.8 % respectively **[21]** and also with **Portalez et al [22].**

Our specificity result was lower than **El-Samei et al& Dola et al.** who reported 94.12%& 93.4%respectively, as they used different equipment; **El-kareem et al** used body coil coupled to an endorectal coil and **Dola et al.** used an endo-rectal coil combined with cardiac coil **[19- 20].**

Considering biopsy-proven Gleason score and not post-prostatectomy pathological grading as a gold stander was one of our study limitations, as well as, using the body surface coil not an endorectal coil in examination which was not available in our institute.

CONCLUSIONS

T2WIand DW-MRI has nearlythe same accuracy in discriminating prostatic nodule however applying total PI-RADs increased this accuracy from 81.1 to 86.1%. PI-RADS V2 using T2WI and DWI is applicable and reliable in discriminating benign and malignant prostatic lesions as it increases the accuracy of MRI in diagnosis of peripheral and transitional zones prostatic lesions.

CONFLICT OF INTEREST

None

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