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Article

Prostate Cancer Diagnosis Accuracy of Bi-Parametric MRI Versus Histological Outcome of Needle Biopsy

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Abstract: Aim: To assess the association between DW MRI images of the prostate and the pathological features of the Tru-Cut (core) biopsy of the prostate's lesions. **Methods:** A total of 55 patients were involved in this investigation. The patients had a mean age of 62.5 years, with PSA levels that were greater than 4 ng/ml, and both DRE and transabdominal pelvic ultrasound exhibited increased prostate size, DRE demonstrated a suspicious, palpable mass, and ultrasound exhibited a hyperactive, enlarged prostate. All patients had a DW MRI of the prostate followed by 12 needle biopsies that were conducted under transrectal ultrasound guidance. Only biopsy samples that were visible on MRI (87 cases) were considered for this study, these cases were divided into prostate cancer, BPH, NSI, and CIG. Multiple lesions from the same patient were also studied. Results: There was a significant difference in the apparent diffusion coefficient of DW-MRI (ADC) between cancerous and non-cancerous lesions in the prostate (BPH, NSI, CIG) ($P < 0.001$).Conclusion: DW-MRI is a reliable tool to determine the presence of cancerous lesions of prostate before commencing with prostate biopsies.

Keywords: DW (Diffusion Weighted), ADC (Apparent Diffusion Coefficient), Prostate Cancer (Pca).

1. Introduction

MRI combined with the systemic twelfth prostate biopsy represents the cornerstone in confirming prostate cancer in men with suspicious nodules felt by DRE [1], or with elevated PSA done as part of a community-based survey, opportunistic survey, or patient inquiry [2].

Histopathological study of prostate biopsies sometimes fails to identify small tumors, putting the patient at risk of unnecessary morbidity and delay of treatment, in other occasions under-grading may put the patient at risk of delaying treatment of high-risk tumors [3].

There is a worldwide movement to prioritize MRI results over prostate biopsy and use the images' characteristics in the decision-making of prostate biopsy procedures and its correlated results [4].

Many radiology departments utilize multiparametric MRI in the diagnosis and treatment of PCA [5]. Also, PIRADS is considered by many radiologists to be a risk assessment method that is extremely beneficial for the early detection of patients with PCA [6]. Additionally, diffusion-weighted imaging (DWI) has the ability to differentiate between healthy and sickening areas by measuring the apparent diffusion coefficient, it

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can also be combined with other diagnostic methods, especially in large centers with a high volume of patients [7].

Trans-rectal Ultrasound is used to plan prostate biopsies, however, prostate lesions in most instances are not sonographically detectable, and these biopsies are taken in a (blind) manner, called systemic biopsies [8].

In our practice, opportunistic PSA screening is the main method of determining the possibility of Pca, and deciding to proceed with further patient evaluation [9].

The positive predictive value (PPV) of a known elevated PSA level was 42%, and the PPV of DRE was 31%. [10].

MRI imaging has been used as a tool to decrease the morbidity of unnecessary prostate biopsies of non-cancerous prostate lesions that can be followed up without significant risk of progression [11], [12].

DW-MRI and the ADC were extensively studied as a reliable modality to differentiate cancerous lesions of the prostate from benign ones [13].

Our study aims to determine the DW-MRI results' reliability for different suspicious prostate lesions. It compares the histopathological results of the biopsies to find the cancerous characteristics vs. the benign ones regarding ADC values.

2. Materials and Methods

The investigation was conducted at the Department of Radiology, Sheikh Zayed Government Hospital, in Baghdad, Iraq. After obtaining consent, the researchers analyzed medical images and pathology reports of 55 patients. Each patient was referred for evaluation of symptoms related to the lower urinary tract and underwent a digital rectal exam (DRE) by a urologist/ specialist, which demonstrated an increased PSA level (greater than 4 ng/ml) with suspicious nodules.

Clinical information was documented for each patient and included: age, PSA result, International Prostate Symptom Score- IPSS, previous systematic biopsy, additional relevant history (treatment of BPH/ surgical or medical), and digital rectal examination findings.

A pelvic MRI exam was performed with T1, T2, and DWI of the prostate, all had one or more MRI-visible suspicious lesions, followed by TRUS- 12 cores tru-cut prostate biopsy and histopathological study in another governmental lab.

Only histopathological results of biopsies of the lesions which are visible by MRI were included in the study, any detectable abnormalities or cancers which were detected by systemic biopsies without documented MRI abnormalities were excluded.

ADC of the prostate lesions which were found to be adenocarcinoma by biopsy; was compared to ADC of the benign lesions.

MRI scan

At the Department of Radiology, Sheikh Zayed Government Hospital, Baghdad, we utilized a 1.5T CS MRI machine from Philips. A dual-parameter MRI of the prostate was conducted using the following sequences: T1-weighted, T2-weighted, and diffusion-weighted.

The patient was assessed in the supine position. After placing the localizer, conventional pictures were taken of the aortic split to the pubic symphysis. The dual-parameter sequence was comprised of:

1. Axial T1WI spinecho scan, with a repetition time of TR/TE (520/15), the thickness of the slices is 5 mm, the interval between them is 1 mm, the field of view is 20 cm, and the matrix is 256x192. The rotation is 90 degrees.

2. High spatial resolution, axial T2-weighted fast spinecho imaging of the prostate and seminal vesicle (TR/TE 3500/90, slice thickness 5 mm, slice interval 1 mm, field of view 25 cm, 256 × 192 matrix, 90 degree flip angle).
3. Coronal and sagittal T2-weighted fast spin echo images of the prostate and the seminal vesicle (TR/TE 4100-4500/90, 4 mm slice thickness, 1 mm slice interval, field of view 38 cm, 256 × 192 matrix, 90 degree flipping angle).
4. weighted diffusion imaging: Single-shot echocardiography that employs a pair of rectangular gradient pulses that are oriented along three different vectors in order to cover the entire prostate. The imaging parameters were (TR/TE: 2800/74; FOV = 38cm^2; layer thickness 3mm, layer spacing 1mm. The matrix had a size of 256 × 256. The b value (the factor that determines how sensitized the area is) was 0 and 1000s/mm2, respectively, and the rotation angle was 90 degrees.
5. Apparent diffusion coefficient: The software built into the machine was used to calculate the apparent diffusion coefficient. The area of interest (ROI) was altered as much as possible within the lesion, avoiding normal tissue adjacent to the lesion, and 1-3 measurements were taken as the average of a single lesion. To verify that the ADC is representative of the normal tissue, the comparison was made with the reference normal tissue. The outcomes of normal tissue from the same prostate were not considered in the investigation. The unit of measurement is mm2/s.

Histopathologic study

TRUS twelfth core tru-cut biopsy was done by an experienced urologist, within one month from each MRI examination, proper evaluation of the patient's health was done with the exclusion of patients with anal pathologies or bleeding tendencies, a peri-procedural oral antibiotic was given, the procedure was done under local anesthesia, three biopsies were taken from lesions detected by MRI along with the rest systemic biopsies (eleven additional biopsies from other zones of the prostate), fixation was done with formaldehyde with separated samples in labeled 12 lab tubes, samples were embedded in paraffin and sectioned, proper staining was done with H-E stain and microscopic examination done by a histopathologist experienced in prostate cancer cases, results of MRI were not disclosed to the histopathologist.

Data and Statistics

The analysis of data was conducted using SPSS version 13 software (SPSS Inc., Chicago, Illinois, USA). Mann-Whitney U tests, Student's t tests, ANOVAs, and post hoc analyses were employed for data analysis. A probability p value of 0.05 or less was considered to have a significant statistical significance.

3. Results

The patients' ages were between 53 and 75 years (median, 63.3±7.5), their PSA levels were between 4.2 and 9.6 ng/mL (median, 7.1±2.6), and their prostate weight was between 31 and 80 g (median, 47.6±19).

Based on the pathological results, the patients were categorized into two groups: the prostate adenocarcinoma group and the benign lesion group..

The patients with adenocarcinoma, mean age was 67 ± 8.3 SD (min-58–max-73 years), the patient's mean serum total PSA was 7.75 ± 2.25 SD (min-4.62–max-9.04 ng/mL), and the patient's mean prostate volumes was 44.7 ± 8.9 SD (min-31–max-78 gr).

In patients who had benign lesions, the mean age was 60.5 ± 6 SD (min-53–max-71 years), the patient's total serum PSA mean values were 7.02 ± 3.45 SD (min-4.02–max-8.90 ng/mL), and the prostate volumes mean was 47.6 ± 19.9 SD (min-32– max-70 gr), see Table/1.

Table 1. All patient groups' data (age, total serum PSA, and prostate volume).

	Total	**Benign**	**Malignant**	***P* value**
Number of patients	55	35	20	

	Total	Benign	Malignant	*P* value
Age	(53–75) mean 63 years	(53–71) Mean 60 years	(58–73) Mean 69 years	*P* = 0.031 Statistically significant.
Total Serum PSA	(4.2–9.6) mean 7.1 ng/mL	(4.02–8.90) Mean 7.02 ng/mL	7.75 (4.62–9.04) ng/mL	*P* = 0.303 Statistically insignificant
Prostate Volume	(31–90) Mean 47.6 gm	(32–70) Mean 47.6 gm	(31–78) Mean 44.7 gm	*P* = 0.664 Statistically insignificant

Of the 55 patients, 20 had cancerous lesions in the prostate, and 35 had non-cancerous lesions (mainly hyperplastic andinflammatory conditions). Multiple lesions were identified on MRI, the Tru-Cut method was employed to collect samples for histological analysis and individual examinations.

A total of 100 lesions were gathered from 20 patients that had prostate cancer. The results demonstrated that 25 patients had adenocarcinoma, and 75 patients had non-cancerous lesions. The results of MRI scans of all lesions were anomalous and exhibited abnormal, diffuse images (DW) and diffuse cancer (ADC).

Biopsy samples were collected from patients that didn't have cancer of the prostate, a total of 256 lesions were collected from 35 patients. 212 patients had primary hyperplasia of the prostate that was consideredbenign, and 44 patients had inflammation. The results of MRI scans of all patients demonstrated anomalous, weighted images (DW) and an anomalous, cancerous growth (ADC).

There was a significant difference ($P < 0.05$) in the mean ADC value of all lesions in the biopsies of MRI-suspicious lesions in PCa patients compared with the mean ADC value of all lesions in non-PCa patients (1.51 ± 0.19 and 1.65 ± 0.18 × 10−3 mm2/s, respectively).

Table 2. ADC of all foci of PCa patients and non-PCa patients

	Prostate Ca (20 patients and 100 foci)	Benign pathology (35 patients and 256 foci)	*P* value
Mean ADC ($\times 10^{-3}$ mm²/sec)	1.51 ± 0.19	1.65 ± 0.18	*P* = 0.037 Statistically significant

There was a significant difference in the mean ADC value of cancerous lesions versusbenign ones (25 and 75 lesions, respectively) in PCa patients ($P < 0.05$). The average ADC value of the malignant lesions was 1.34 ± 0.43 × 10-3 mm2/s, while the average ADC value of the benign lesions was 1.57 ± 0.29 × 10-3 mm2/s (Table 3). There was a significant difference in the mean ADC value of the malignant tumors in PCa patients versus the mean ADC value of the BPH tumors in non-PCa patients (25 and 212, respectively) ($P < 0.05$). The average ADC value of the malignant tumors in PCa patients was 1.34 ± 0.43 × 10-3 mm2/s, while the average ADC value of the BPH tumors in non-PCa patients was 1.63 ± 0.28 × 10-3 mm2/s, see Table 3.

Finally, there was a statistically significant difference ($P < 0.05$) in the mean ADC values of malignant lesions in PCa patients and inflammatory lesions (confirmed by histopathological examination) in non-PCa patients (25 and 44 lesions, respectively). The average ADC value of the malignant tumors in PCa patients was 1.34 ± 0.43 × 10-3 mm2/s, while the average ADC value of the BPH tumors in non-PCa patients was 1.76 ± 0.24 × 10-3 mm2/s, see Table 3.

Table 3. ADC of all benign and malignant of both patient groups

	AdenoCa Foci (25 foci)	Prostate Ca Benign Foci (75 foci)	BPH Foci (212 foci)	Chronic Inflammation Foci (44 foci)	*P* value
Mean ADC ($\times 10^{-3}$ mm^2/sec)	1.34 ± 0.43	1.57 ± 0.29			$P = 0.015$*
	1.34 ± 0.43		1.63 ± 0.28		$P = 0.025$*
	1.34 ± 0.43			1.76 ± 0.24	$P = 0.0001$*

∗statistically significant.

4. Discussion

Prostate cancer is still one of the most common cancers in men worldwide (excluding non-melanoma skin cancer) [14]. It has a high rate of cure. Early and accurate diagnosis is the foundation of effective treatment [15].

Traditionally, digital rectal exam (DRE) and the prostate-specific antigen (PSA) have been the most popular diagnostic procedures for prostate cancer. The probability of a positive diagnosis for PSA is 42%, and for DRE it is 31%. When DRE and PSA are incorporated into a screening or diagnosis regimen in patients that are clinically suspected, the positive predictive value is 60% [16].

Of all patients with prostate cancer, 18% require a biopsy due to the ambiguous results of the DRE, this is particularly true of those located in the peripheral tissue, the DRE can feel 0.2 ml of tissue, regardless of the PSA level [17].

In our practice, TRUS is primarily used for diagnostic purposes and is not considered a screening tool because it is an invasive procedure and can be replaced by other tests, including DRE and PSA, as well as MRI, these other tests identify patients who have a high risk of having TRUS biopsies. These other tests are reserved for TRUS [18]. The practice of PSA detection is a controversial subject. Some countries utilize community screening that is covered by health insurance, while others do not. In our practice, we offer screening without a specific test for the presence of PSA with a threshold of 4 ng/ml. However, even in patients whose PSA levels are in the gray area of 4-10 ng/ml, some post-biopsy results that are elevated still indicate disease that is consideredbenign, and some aggressive cancerous prostate diseases are diagnosed at PSA levels of less than 4 ng/ml [19]. As a result, MRI is a significant tool in the diagnosis of disease that facilitates the accurate exclusion of significant PCA components and the avoidance of overdiagnoses [20]. In this context, the combination of digital rectal exam (DRE), a measure of PSA in the prostate, and systematic biopsies of the duodenal portion of the prostate with MRI can increase the yield of prostate cancer diagnoses [21].

We developed a parameter that allows the comparison of DWI scans of healthy and cancerous lesions. We employed MRI and a Tru-Cut needle biopsy to associate the same lesions with histopathological analysis. We think that DWI is alone more effective at diagnosis and differentiating between healthy and sickening lesions [22].

Similar investigations have been conducted in other locations with identical methods.

Issa B. employed anecho-planar imaging to determine the ADC of the peripheral regions of cancerous lesions and non-cancerous lesions, he found that the ADC value of the cancerous tissue was significantly less than that of the normal tissue [23].

Sato et al. They carried out a similar investigation on 29 patients that were suspected of having lesions. The researchers conducted a prostate Tru-Cut biopsy, which divided the patients into 23 patients with cancer and 6 patients with non-cancerous conditions. Later, the researchers inspected the DWI images, recorded the ADC value of cancerous lesions in the prostate, and contrasted these values with those of benign lesions. The results demonstrated that the ADC value of cancerous lesions was lower, while the ADC value of benign lesions was higher, there was a significant difference in the statistical population [24]. Also, Tan et al. conducted a meta-analysis of 19 articles with a total of 5,892 lesions,

the results of which showed that DWI had a higher degree of accuracy in diagnosing cancerous lesions in the prostate than did biopsy [25].

5. Conclusion

DW-MRI is crucial to the assessment of patients with a suspicion of prostate cancer. Targeted biopsy of the affected region may enhance the diagnostic value of histopathology over the entire body, this is accomplished using transrectal ultrasound guidance. ADC can be employed to differentiate patients who are thought to have benign tumors based on the measurement alone, this will prevent the unnecessary execution of prostate biopsies..

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