Research Article

Prostate carcinoma detection: Moving from multiparametric to bi-parametric magnetic resonance imaging

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ABSTRACT

Background: Prostate carcinoma screening tests usually include digital rectal examination (DRE) and prostate-specific antigen (PSA) levels. If these tests detect some abnormality, further evaluation is recommended using transrectal ultrasound (TRUS), TRUS guided biopsy, or magnetic resonance imaging (MRI). MRI is a preferred tool among three as its non-invasive and has high sensitivity and specificity. In MRI, most of the medical centers perform multi-parametric MRI. The present study is an endeavor to evaluate the feasibility of using biparametric study for detection of prostate cancer; thereby reducing the scan time and avoiding the use of contrast. **Objective:** The objective of the study was to compare the diagnostic efficacy of using biparametric MRI (T2-weighted imaging [T2WI] and Diffusion-weighted images [DWI]) for detection of carcinoma prostate as compared to multiparametric MR study which in addition also includes dynamic contrast-enhanced (DCE) and spectroscopic MRI sequences. **Materials and Methods:** This prospective cross-sectional study included 60 patients suspected to have prostate cancer on the basis of PSA levels and DRE. All the patients underwent pretreatment MRI on 1.5 T scanner followed by TRUS guided biopsy. MRI protocol included T1-weighted images, T2W, DWI, DCE MRI, and MR spectroscopy. The diagnostic performance of T2WI + DWI and multi-parametric MRI for diagnosis of prostate cancer was determined and compared with each other using histopathology as the gold standard. **Results:** The sensitivity for detection of carcinoma prostate for biparametric MRI (T2WI + DWI) is 63.3%, specificity 78.95%, positive predictive value (PPV) 86.6%, and negative predictive value of (NPV) 50.00%. The sensitivity of multiparametric MRI was 78.05%, specificity 68.42 % with PPV 84.2%, and NPV of 59.09%. **Conclusion:** For the detection of prostate cancer biparametric (DWI/T2WI) and multi-parametric MRI both showed comparable results. Multi-parametric MRI involves the administration of intravenous contrast and requires longer acquisition time; T2/DWI is faster and non-contrast sequences and is workhorse sequence in the detection of prostate cancer.

KEY WORDS: Multiparametric; Biparametric; Carcinoma Prostate; Magnetic Resonance Imaging

INTRODUCTION

Prostate cancer is a disease of elderly men. The estimated age-standardized incidence rates in India is 4.4 cases/ 100,000 (WHO 2018) and is seventh most common cancer in India.[1] Clinically, the patients with prostate cancer in early stages may be asymptomatic; in later stages, symptoms include hematuria, nocturia, urgency, frequency, hesitancy, and bone pain if there is metastasis.[2]

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There are no clear cut guidelines as to whether to screen healthy people for prostate carcinoma. Digital rectal examination (DRE) and prostate-specific antigen (PSA) are commonly used for the evaluation of patients suspected of prostate carcinoma.[2] PSA level is often the first to rise

in cancer prostate. Its normal value is <4 ng/ml and level >10 ng/ml indicates the need for biopsy.[2] However, it is not a specific marker of prostatic cancer, as its level rises in prostatic inflammation and benign prostatic disease as well.[3]

If these tests detect some abnormality, further evaluation is recommended using transrectal ultrasound (TRUS), TRUS-guided biopsy, or magnetic resonance imaging (MRI). TRUS with a frequency range of 5–8 MHz can be used for evaluation of both benign and malignant disease of the prostate. However, the findings on TRUS are very non-specific with an overlap in both benign and malignant diseases. TRUS guided biopsy is the gold standard for diagnosis of prostate carcinoma; however, it is invasive.

In view of limitations with PSA, DRE, and TRUS, MRI has emerged as the modality of choice for detection of prostate cancer due to its excellent soft tissue resolution. MRI has the advantage of being a non-invasive tool with high sensitivity and specificity. Zonal anatomy of the prostate gland is best depicted on T2-weighted imaging (T2W) scan. The tumor appears hypointense within the homogenous high signal intensity of the peripheral zone. However, other lesions such as focal prostatitis, post-biopsy hemorrhage, and benign prostatic hyperplastic nodule may mimic cancer nodule on conventional MRI sequence.[4,5] Hence, using conventional sequences alone was not enough. Nowadays, multiparametric MR has become standard for evaluation of the prostate. Many studies in the past highlighted the role of diffusion-weighted images (DWI) and dynamic contrast-enhanced (DCE) in prostate cancer and evaluated how the addition of these sequences increases the diagnostic performance of MR in the detection of cancer prostate. Prostate imaging reporting and data system version 2 has provided comprehensive guidelines for the use of multiparametric MRI in the detection of prostate cancer.[6]

Since there are so many parameters in the multi-parametric MRI, it is time-consuming. In addition, intravenous gadolinium has to be administered, which is not always possible in patients with deranged renal functions. Furthermore, the long-term effects of gadolinium deposition in the human body are still not known. One of the components of multiparametric MRI is MR spectroscopy, which is time consuming and requires the proper implementation of various variables which is difficult in routine clinical practice.

There is a dilemma in literature as to which sequences are to be recommended for the diagnosis of prostate cancer. The present study is an endeavor to evaluate the feasibility of using biparametric study for detection of prostate cancer; thereby reducing the scan time and avoiding the use of contrast. For the purpose of staging, T1-weighted images (T1WI) and contrast-enhanced study might be useful.

Aims and Objective

The aim of the study was to compare the diagnostic efficacy of using biparametric MRI (T2WI and DWI) for detection of carcinoma prostate as compared to multiparametric MR study which also includes DCE and spectroscopic MRI sequences using histopathology as the gold standard.

MATERIALS AND METHODS

The study was conducted in a tertiary hospital in the department of radiology in collaboration with the department of urology. This prospective study was given Institutional Ethical Clearance (Institutional Review Board). A total of 60 patients presumed to have prostate cancer on the basis of lower urinary tract symptoms with raised PSA levels >2.5 ng/ml or with a hard, nodular prostate on DRE were included in the study. Any patient with documented prior treatment for any prostatic disease or patients with any contraindication to MRI were excluded.

MRI Technique

Patients were imaged using Philips 1.5 T whole-body MRI Intera Achieva machine using a dedicated pelvic coil.

- Conventional MR: T1WI were obtained in the axial plane with a T1-weighted turbo spin-echo sequence. Similarly, T2-weighted images were obtained in axial, coronal, and sagittal planes. These sequences were used to locate tumor lesions and to reveal their morphologic characteristics.
- Diffusion-weighted data were acquired using single shot echo-planar imaging sequences (TR/TE = 2500/64 ms, section thickness = 6 mm, slice gap = 0.6 mm, matrix = 80 × 128, field of view [FOV] = 160) at B value 0, 1000, 1500 and 2000.
- DCE scan was obtained by administering intravenously gadopentetate dimeglumine at a dose of 0.1 mmol/kg at a rate of 2.5 ml/s followed by 20 ml of saline flush. DCE MRI was performed using multislice fast spoiled gradient recalled sequence (TR = 4.3 ms, TE = 2.1, slice thickness 2 mm, matrix 256 × 192, FOV = 395 × 70, number of slices = 100).
- Multi-voxel MR spectroscopy was performed for prostate.

Image Analysis for Detection

T2W

Sequences were reviewed. In the peripheral zone, any hypo-intense focal lesion (excluding linear and wedge-shaped hypointensities) on T2W sequence without any hyper-intensity on T1WI sequence was considered suggestive of prostate cancer.[6] In the transitional zone, any intensely T2 hypointense lesion with ill-defined margins was considered positive for carcinoma.

ure 1 reveals hypointense nodule in peripheral as well as transitional zone suggestive of carcinoma.

Diffusion-weighted scan

Prostate carcinoma was diagnosed on DWI and apparent diffusion coefficient (ADC) map if the area on the diffusion-weighted image at b = 1000 showed bright signal with the corresponding dark signal on the ADC map. Tissue with ADC value less than ($0.86 \pm 0.33 \times 10^{-3}$) was considered malignant.[6] Figure 2 from the same patient as in Figure 1 reveals areas of restricted diffusion in peripheral as well as the transitional zone.

For combined data of T2W + DWI, prostate carcinoma was considered positive if either of the image was positive.

DCE

Study intensity-time curve was obtained using perfusion software and curves were classified as below.

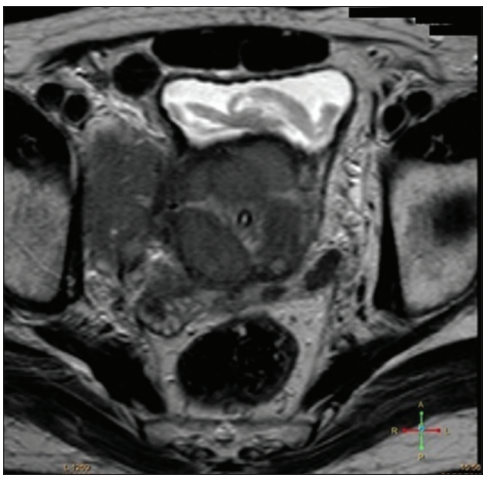

Figure 1: T2WI axial MR image shows multiple hypointense nodules in both the peripheral zones and transitional zone. Also there is capsular breech on right side with right pelvic lymph node

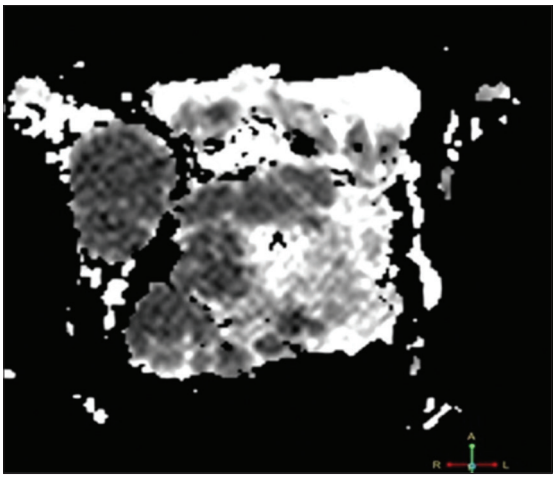

Figure 2: ADC map of same patient as in Figure 1 reveals hypointensity in prostatic nodules and also in right pelvic lymph node suggestive of restricted diffusion

Time Intensity Curves

- Type A curve – Rapid peak enhancement within 60 s. It was considered malignant for a lesion in the peripheral and central zone. Figure 3 reveals the type A curve with peak enhancement at 60 s followed by contrast washout
- Type B curve – Peak enhancement within 100 s. It was considered malignant only in the peripheral zone. Figure 4 reveals the type B curve
- Type C curve – Delayed enhancement and no signal peak after a continuous increase in signal intensity for 3 min. These were considered benign for peripheral as well as a central zone.[7]

Within 2 weeks after MRI, all the 60 patients underwent TRUS guided biopsy. The patients diagnosed as prostate cancer on biopsy were operated or given appropriate treatment depending on the individual case.

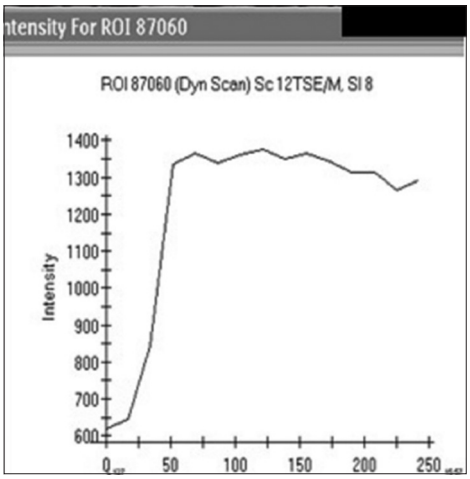

Figure 3: Dynamic contrast enhanced image shows rapid enhancement within 60 seconds followed by contrast washout (Type A curve)

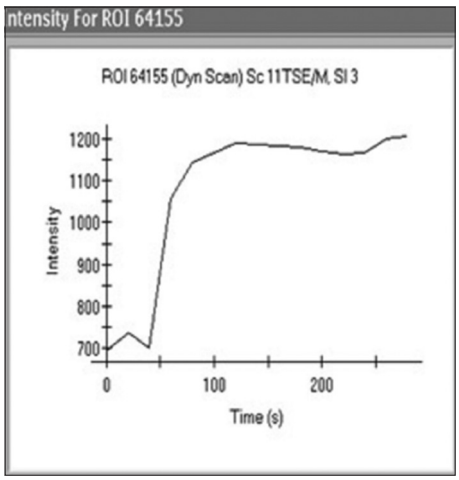

Figure 4: Dynamic contrast enhanced image shows enhancement within 100 seconds (Type B curve)

Statistical Analysis

MRI and TRUS guided biopsy/surgical-pathologic findings were compared, and statistical analysis was performed, with $P \leq 0.05$ indicating a statistically significant difference. With the use of a 2 × 2 contingency table, descriptive statistics (accuracy, sensitivity, specificity, positive predictive value [PPV], and negative predictive value [NPV]) were calculated for detection of prostate cancer for T2WI + Diffusion MR and multiparametric MR. McNemar's test was used to compare the sensitivity and specificity of MRI sequences. The confidence interval was calculated according to the efficiency score method.

RESULTS

A total of 60 patients clinically suspected to have prostate cancer were enrolled in the study. The age of the patients ranged from 51 to 90 years. Maximum patients were in the age group 61 to 70 years.

All patients included in the study underwent MRI examination followed by TRUS guided biopsy. Detailed MRI findings on T2WI+DWI and multiparametric MRI were obtained and recorded to the above-described imaging criteria. The biopsy result is illustrated in Table 1. The imaging findings on biparametric MRI and multiparametric MRI as compared to histopathological findings are mentioned in Tables 2 and 3. Comparison of sensitivity, specificity, PPV, and NPV between biparametric and multiparametric MRI is shown in Table 4.

DISCUSSION

Prostate enlargement is a frequent clinical problem encountered by urologist, which is initially evaluated by DRE and PSA estimation. The imaging modality for this group of patients is TRUS and MRI. Overlapping imaging appearances of benign and malignant nodules on TRUS and conventional MRI explains the need for more decisive imaging techniques. In the present study, we have compared the efficacy of DWI + T2WI and multiparametric MRI for the diagnosis of prostate cancer using histopathology as the gold standard. For the comparison between biparametric MRI and multiparametric MRI, both the sequences improved the detection rate of cancer prostate when added to T2WI. Both techniques had comparable PPV; however, NPV of multi-parametric MRI is slightly higher than biparametric MRI; with higher specificity for biparametric MRI. Thus, we can see that the results are comparable, but since multiparametric MRI involves administration of contrast which has known and unknown short-term as well as long-term side effects. Second, performing multiparametric MRI is a time-consuming process. Third, the results of spectroscopy examination are variable from the scanner to scanner and need to be performed very accurately for better results. Hence, biparametric MRI scores over multiparametric MRI in the detection of prostate cancer.

Table 1: TRUS biopsy findings in patients clinically suspected to have prostate cancer (*n*=60)

Findings	Number of patients	Percentage
Prostate cancer		
Present	41	66.6
Absent	19	33.3
Gleason score in patients with prostate cancer (41)		
≤n	4	9.75
≥7	37	90.2

Table 2: Biparametric MRI in the detection of prostate cancer with its biopsy result (*n*=60)

T2+DWI finding	Histopathology positive	Histopathology negative	Total
Imaging positive	26	4	30
Imaging negative	15	15	30
Total	41	19	60

DWI: Diffusion-weighted images

Table 3: Multiparametric MRI findings with biopsy result *n*=60

DCE result	Histopathology positive	Histopathology negative	Total
Imaging positive	32	6	38
Imaging negative	9	13	22
Total	41	19	60

DCE: Dynamic contrast-enhanced

The diagnostic efficacy of T2WI and its limitations has been reported by various authors in the past.[4,5] The diagnostic efficacy of T2WI reported by authors, namely Schlemmer *et al*., Girouin *et al*., Li *et al*., Miao *et al*., and Kim *et al*. has been variable depending on the methodology and MRI scanner used.[7-11] Diffusion-weighted scan due to its excellent result in brain imaging is increasingly being used now in abdominal and pelvic imaging, including prostate. Some of the initial DW studies on prostate were by Gibbs *et al*. and Issa *et al*. who reported that the ADC value in prostate cancer is lower than the normal prostatic tissue.[12,13] Subsequently, the diagnostic role of DWI in the detection of carcinoma prostate has been evaluated by various authors at variable b values. In our study, 30 out of 60 patients showed restricted diffusion with ADC value ($0.86 \pm 0.33 \times 10^{-3}$). In the remaining 30 patients, there was no restriction of diffusion. The sensitivity of our study was similar to the sensitivity reported by Kozlowski *et al*. (35–72%) in detection, but the specificity in this study was much higher (95–100%) than in our study.[14] The difference in the result may be explained by the use of endorectal coil by the author. A study done by Haider *et al*. reported increased sensitivity of T2W + DWI 81% over T2WI alone 54% with

Table 4: Comparison of biparametric and multiparametric MRI in detection of prostate cancer

MRI protocol	Sensitivity (%) (C.I.%)	Specificity (%) (C.I.%)	PPV (%) (C.I.%)	NPV (%) (C.I.%)	Accuracy (%)
T2+DWI	63.3 (46.9–77.4) (χ^2=8.311, *P*=0.0039)	78.95 (53.9–93.0) (χ^2=15.2, *P*=0.0001)	86.6 (68.3–95.6)	50 (31.6–68.3)	68.3
Multiparametric	78.05 (61.9–88.8) (χ^2=11.512, *P*=0.0007)	68.42 (43.4–86.4) (χ^2=14.17, *P*=0.0002)	84.2 (68–93.4)	59.09 (36.6–78.5)	75

C.I. refers to 95% confidence interval calculated according to the efficiency score method. χ^2 and *P* value calculated using Mc Nemar's test, $P \leq 0.05$ considered significant, DWI: Diffusion-weighted images

slight loss of specificity from 91% to 84% for detection and localization of prostate cancer.[15] In our study also DWI and T2WI data combined together was better in the detection of prostate cancer as compared to T2WI alone. DCE MRI in the detection of malignant tissue is based on tumor angiogenesis and vascular permeability.[16,17] Some of the initial study by Ito *et al*. and Engelbrecht *et al*. demonstrated the difference in the enhancement pattern between normal prostate and malignant nodule.[18,19] Our result was comparable to the result reported by Ito *et al*.[18]

CONCLUSION

MRI is a single comprehensive modality of choice for evaluation of the patient with suspected cancer prostate. We concluded that instead of using multiparametric MRI in all patients suspected of prostate carcinoma; biparametric MRI should be preferred as it avoids the administration of intravenous contrast (avoiding its side effects) and also reduces the scan time for patients.

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