Original Research Article

Diagnostic accuracy of Multiparametric MRI in detection of prostate cancer compared with histopathology obtained by MRI directed TRUS guided cognitive fusion biopsy are T2WI, DWI and DCE enough for Indian scenario

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Abstract

Background: The incidence of prostatic carcinoma is increasing worldwide. With its high resolution, ability to provide excellent tissue characterization and multiplanar imaging capabilities, multi-parametric magnetic resonance imaging (mpMRI) plays a crucial role in detection, local staging and follow-up of carcinoma prostate. It also helps guide targeted biopsies in initial biopsy negative patient. **Objectives:** Study diagnostic accuracy of mp-MRI and primarily that of the three MR sequences T2, DWI and DCE in detection of prostatic cancer by correlating them with histopathology and thus whether it is feasible for a short MRI of 3 sequences to be used on a large scale in Indian scenario. **Materials and Methods:** A prospective study was done at a tertiary care hospital between April 2017 to November 2018 in which 50 patients who presented with suspicion of prostate cancer were referred to radiology department for evaluation using MRI. MRI examination was done using 3T Siemens Magnetom Verio. Followed by this MRI directed TRUS guided cognitive fusion biopsy was done from the prostate. Samples were sent for histopathology. **Results:** Out of 50 cases studied, 24 cases (48%) were found to be malignant and 26 cases (52 %) were benign on histopathology. In our study, combined T2 + DWI + DCE gave sensitivity of 95.83 %, specificity of 57.69%, positive predictive value of 68.21 % and negative predictive value of 93.75%. **Conclusion:** Multiparametric MRI using T2, DWI and DCE has a high diagnostic accuracy for evaluation of prostatic cancer.

Keywords: Multiparametric MRI, prostate cancer, cognitive fusion TRUS biopsy.

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INTRODUCTION

The incidence of prostatic diseases is increasing worldwide including prostate cancer. In many industrialized nations, it is one of the most common cancers and among the leading causes of cancer deaths. In developing countries it may be less common, however its incidence and mortality has been on the rise.[1] It has a very high prevalence of occult disease. Incidence of prostate cancer is also showing a rising trend in India.[2] Transrectal Ultrasonography is the first imaging modality for evaluation of prostatic pathologies. High-resolution imaging of transrectal ultrasound provides high diagnostic accuracy.[3,4] However, there are some shortcomings with this modality, such as

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the limited field of view, inherent limitations dependent on patient size and its dependence on the skill and experience of the operator. With its high contrast resolution, its ability to provide good tissue characterization and its multiplanar imaging capabilities Multi-parametric magnetic resonance imaging (mpMRI) plays a crucial role in detection, local staging, restaging , post-treatment follow-up of carcinoma prostate. It also helps for targeted biopsy in initial biopsy negative patients.[5] The primary sequences evaluated are T2 weighted imaging, Diffusion weighted imaging (DWI) and dynamic contrast enhanced (DCE) imaging with perfusion kinetics.[6] India has a scarcity of MRI machines, and the existing machines have an extremely high patient volume. India does not yet have a standardized protocol for prostate cancer MRI, with many institutions taking more than 8 to 10 sequences leading to an imaging time of more than 1.5 hours for one prostate MR patient. Limiting imaging to only 3 sequences of T2, DWI and DCE would decrease imaging time to less than 15 minutes. This would allow more prostate MR patients to be imaged, potentially reduce MRI costs for the patient and ensure optimum utilization of the scarce resources.

Aim

Study diagnostic accuracy of mp-MRI and primarily that of the three MR sequences T2, DWI and DCE in prostate cancer by correlating them with histopathology and thus to determine whether it is feasible for this short MRI protocol to be used on a large scale in Indian scenario.

MATERIALS AND METHODS

A prospective study was done at a tertiary care hospital between April 2017 to November 2018 in which 50 patients who presented with prostate problems were referred to radiology department for evaluation using MRI chosen by purposive sampling technique. The MRI examination was done using3 Tesla Siemens Magnetom Verio (Siemens Healthcare, Erlangen, Germany) with pelvic phased array coils. The following MRI characteristics were noted separately: signal intensity of lesion on T2W MRI, diffusion restriction within lesion, dynamic post-contrast enhancement, extra-prostatic extension on T2W DWI DCE, seminal vesicle involvement on T2W, DWI, DCE and adjacent organ involvement along with regional metastases. PI-RADS score was given according to PI-RADS version 2 as described by the American College of Radiology in 2015.[6] Followed by this, trans-rectal ultrasound guided biopsy was performed using a 18 gauge x 25 cm BARD(New Jersey, USA) Maxcore biopsy gun with a 2 cm throw. Prior to biopsy written consent was taken from the patient. The patient was advised fasting NBM of 6 hours, laxatives, antibiotic prophylaxis and urinary bladder catheterization in morning on day of biopsy. Transrectal ultrasound guided systematic 10 core prostate biopsy was performed with extra samples from the suspicious MRI lesions under local anaesthetic (MRI directed TRUS guided cognitive fusion biopsy).The samples were collected in separate formalin bottles and sent for histopathology. Post biopsy antibiotic and painkillers were advised. The histopathology report was then reviewed. Sensitivity, specificity, positive predictive value, negative predictive valuewere calculated for all sequences separately and combined. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 20 (IBM corporation).

RESULTS AND ANALYSIS

Mean age of the participants was 68 years (range 43 to 82 years), with maximum patients in the age group of 61 to 80 years. Most of the patients (58 %) with prostatic diseases presented with voiding symptoms in our study. In our study of 50 patients, on digital rectal examination 23 patients (46%) had nodule in the prostate. 24 cases (48 %) were found to be malignant and 26 cases (52 %) were benign on histopathological examinations. 28 out of 50 (56%) patients showed ill-defined or well-defined hypointensities in T2 weighted sequence [Figure 1 and 2]. Among these 22 out of 28(78.5%) patients had biopsy proven adenocarcinoma. 68 % among these patients had PI-RADS 5 lesion. There was a statistically significant association between hypointensity on T2 weighted image and malignancy ($P<0.05$). 23 out of 24 patients (95.83 %) with biopsy proven adenocarcinoma showed diffusion restriction on DWI [Figure 1 and 2]. However we found false positive results in 3 patients. There was a statistically significant association seen between diffusion weighted image and biopsy ($P<0.05$), showing significant correlation between diffusion restriction and presence of malignancy.

30 out of 50 (60%) patients in the study population showed early contrast enhancement with rapid washout [Figure 3]. There was a statistically significant association seen between early contrast enhancement and malignancy ($P<0.05$). The dynamic contrast enhancement was able to correctly identify prostate cancer in 91.67% of the cases. Using all three sequences together, combined T2 + DWI + DCE was able to correctly identify prostate cancer in 95.83 % of the cases (sensitivity), while it was able to negate the presence of prostate cancer in only 57.69 % (specificity),it had a PPV of 68.21 % and NPV of 93.75%. The PI-RADS score of 4 and 5 was taken as a positive finding (malignancy). There was a statistically significant association seen between a high PI-RADS score and malignancy on biopsy ($P<0.05$).

DISCUSSION

A review from Kirkham *et al.* (2006) that assessed the ability of MRI to localize disease within the gland showed that detection of cancer was variable[7] Whole-mount histology was used as the reference standard; T2W-MRI scans had a sensitivity of between 37–96%, whereas DCE MRI or MRS reduced this range to 57–89% and 50–86%, respectively. Accuracy of cancer detection also varied according to differences in methodology. This variation was due to a number of factors: the criteria used to define significant tumors (many studies excluded foci <0.5 cm3); the method of analysis; whether endorectal coils or pelvic phased arrays were used (coils improve the signal-to-noise ratio of the prostate); and whether the reference standard was TRUS biopsy or whole-mount histology. In the current study 50 patients with clinically suspected prostate cancer were evaluated by MRI in a 3T system for lesion detection, characterisation, and correlation with biopsies. A group of experts of the European Society of Urogenital Radiology (ESUR) has recently published a guideline for MRI of the prostate to improve the quality of the procedure and reporting. In addition to providing recommendations relating to indications and minimum standards for MR protocols, the guideline described a structured reporting scheme(PI-RADS). High-spatial-resolution T2-weighted rapid acquisition with refocused echo sequences, a small field of view performed with pelvic phased phased-array coils are excellent to depict prostate anatomy and in identifying and characterizing the lesion similar to findings of Hricak *et al.*[8] T1-weighted contrast in the prostate is very low. Therefore, it is not possible to appreciate the different anatomic zones on T1-weighted images. 19 of the cases of prostatic carcinoma appeared as hypointense lesion within the hyperintense peripheral zone. Extra capsular extension, lymph nodes and metastases were also seen well in this sequence. 10 cases of BPH were homogeneously hyperintense on T2. 12 cases were heterogeneous on T2, out of which 2 turned out to benign hyperplasia while 3 turned out to be malignant after the biopsy.

A visible space-occupying component or extra-capsular extension must be interpreted as a reliable sign of malignancy.[9] A diagnostic challenge lies in the non-specific visualization of different but morphologically similar entities such as post-inflammatory or post-biopsy scars, atrophic changes, prostatitis, intraepithelial neoplasias (PIN), or post-treatment lesion.[10] The probability of detection decreases with decreasing size of the lesions.[11] Turkbey *et al.* (2010)[12] revealed that T2-weighted MR imaging alone had the highest sensitivity for PZ tumors alone and for PZ and TZ tumors combined for both small and larger lesions. Their sensitivity varied from 91% to 94% depending on the site.Sensitivity reduced with central lesions and in the presence of hemorrhage. They also reported that sensitivity for T2-weighted MR imaging was significantly higher than it was for dynamic contrast-enhanced MR imaging or MR spectroscopy, and specificity for T2-weighted MR imaging was lower than the others. In prostate cancer, ADC is significantly lower compared to the value in surrounding normal peripheral zone tissue[13] Concurrent review of ADC maps with T2-weighted endorectal MRI has led to an improvement in tumour localization[13] Recent studies have reported that the use of higher b values (1000–2000 s/mm2) improves lesion detection[14] In our study we found a sensitivity, specificity, PPV, NPV of 95.83%, 88.46%, 88.46 % and 95.83% respectively for detection of prostate cancer. Our study results corroborate with the results of Kim *et al.* (2008)[15] who reported sensitivity and specificity to be 98% and 81% respectively. In our study, the combined T2 + DWI + DCE gave sensitivity of 95.83 %, specificity of 57.69%, positive predictive value of 68.21 %, negative predictive value of 93.75 % and diagnostic accuracy of 76 %. Our sensitivity matches with that reported by , Turkbey *et al.*(2010)[12] who reported sensitivity of 86%, Ferda *et al.* (2013)[16] which was 97.6%; and our negative predictive value matches with that reported by Fütterer *et al.*[17] which was from 63% to 98%.

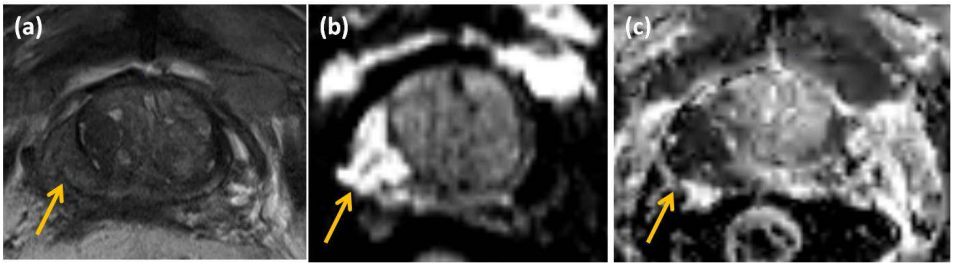

Figure 1: (a) T2W image shows a darkly hypointense lesion in the right lobe of prostate with breach in the prostatic capsule and showing extra-prostatic extension. (b) DWI and (c) ADC images show corresponding strong diffusion restriction within the lesion. Histopathologically proven prostate cancer.

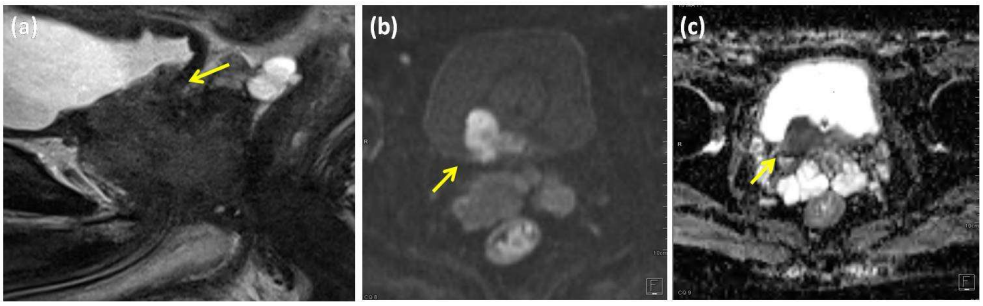

Figure 2: (a) T2W image shows a hypointense prostatic lesion invading the posterior wall of urinary bladder. (b) DWI and (c) ADC images confirm the bladder wall invasion. Histopathologically proven prostate cancer.

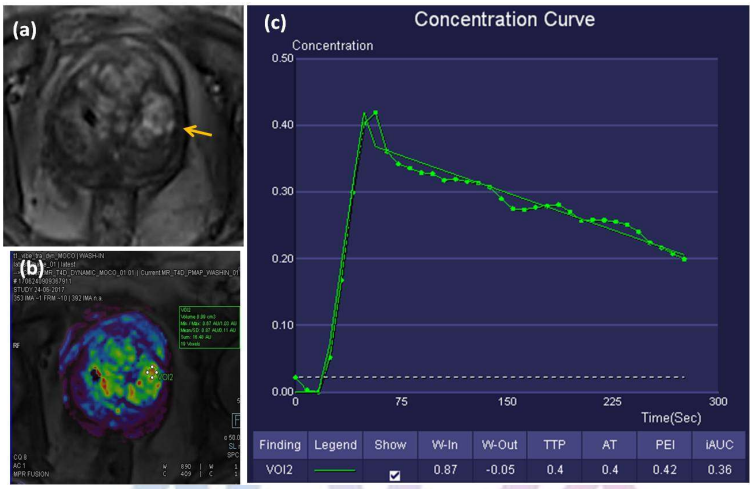

Figure 3: (a) DCE arterial phase image shows early arterial phase enhancement of a lesion in left lobe of prostate. (b) DCE color map shows patchy high perfusion within the leison (c) A type 3 kinetic concentration curve is obtained within the lesion, showing early arterial uptake and rapid washout. Histopathologically proven prostate cancer.

Limitations of our study are that exact mapping of the lesion by clock wise position was not correlated on histopathology for both the TRUS guided biopsy cores and the radical prostatectomy specimens by the pathologists.

CONCLUSION

Using only T2, DWI and DCE provides an excellent diagnostic accuracy in detection and characterization of prostatic lesions. We recommend performing MRI using only these three most important sequences as the first modality of investigation (imaging time of 15 minutes) followed by MRI directed TRUS guided cognitive fusion prostate biopsy which has the potential to improve the detection of clinically significant cancers, decrease negative biopsies and help in early initiation of therapy. Limiting the MRI to only these three sequences significantly decreases imaging time while maintaining the diagnostic accuracy, and provides a protocol to image the maximum number of prostate pathology patients with optimum results.

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