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Role of Magnetic Resonance Imaging in Characterizing Focal Lesions of Prostate with Histopathological Correlation

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ABSTRACT

Common conditions affecting prostate include -BPH, prostate cancer and prostatitis. Prostate cancer is the second most common and fifth leading cause of cancer deaths[1]. Local extension of tumor can be detected using MR imaging and assessment of tumor aggressiveness, can be done using MR spectroscopy[2]. Combined MRI and MRS provide important role in localization and staging of prostate cancer[3]. To determine the role of magnetic resonance Imaging in characterizing focal lesions in the prostate using histopathological findings as a reference standard[1]. To determine the T1 and T2 signal characteristics of various focal lesions of prostate[2]. To characterize focal lesions using magnetic resonance spectroscopy. In a total of 30 patients, who have been referred to the Department of Radio-diagnosis, SMVMCH for MRI in suspected focal lesions of prostate or for evaluation of focal prostatic lesions diagnosed in ultrasound, during the period of November-June 2019-2021. The patients were subjected to MRI for T1-T2 and MRSI characteristics, which was correlated with intraoperative and histopathological reports. Data was entered into Microsoft excel data sheet and was analyzed using SPSS 25 version software. Out of 30 patients, 14 (46.7%) had carcinoma prostate, 8 (26.7%) had BPH and 8 (26.7%) showed inflammatory changes. Sensitivity, specificity and accuracy of T2-weighted images and MRSI were 71.4%, 87.5 %, 80.1 % (Fisher's Exact Test showed p<0.004) and 85.7%, 87.5 % and 86.6 % (p<0.001) respectively. MRSI demonstrated higher sensitivity, specificity and accuracy compared to T2-weighted images. T2W MRI and MR spectroscopy have a great sensitivity for detecting and distinguishing organ restricted prostate cancer from other benign causes. MR spectroscopy is more sensitive and specific than MRI alone, hence recommended for combined imaging with MRI and MR spectroscopy.

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Key Words
Prostate carcinoma, prostatitis, benign prostatic hyperplasia, MRI

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INTRODUCTION

Prostate gland is situated below the level of urinary bladder between pubic symphysis and rectum. Common conditions affecting prostate includes-BPH, prostate cancer and prostatitis. Prostate cancer is one of the most common cancers in elderly men, affecting predominantly the peripheral zone of prostate[1].

Local extension of the tumor can be detected by MR imaging and tumor aggressiveness with assessment of the tumor can be done by MR spectroscopy[2]. Combined MRI and MRS provides important role in localisation and staging for the prostate cancer, which will help in the management planning[3].

BPH is commonest in elderly men and usually very few of them will require surgical or medical interventions. It has two effects. It predominantly involves the central zone of prostate. Static effect is due to the enlargement of glandular components, that lead to the increase in size of the gland and causes obstructive symptoms. Dynamic effect is basically where there is increase in the resistance of parenchyma[4].

Prostatitis refers to inflammation of the prostate. Chronic prostatitis presents with gradual symptoms and PSA level will be elevated as in acute prostatitis or carcinoma. In such conditions prostate cancer should be ruled out, as chronic prostatitis and prostatic carcinoma can share similar imaging features[5].

MATERIALS AND METHODS

Study setting: The present study was conducted in the Department of Radio diagnosis of Sri Manakula Vinayagar Medical College and Hospital (SMVMCH) Kalitheerthalkuppam, puducherry, India, which is a well-equipped, multi-specialty hospital with approximately more than 900 beds.

Study design: This study is a hospital based cross sectional study.

Study participants: All patients referred to the Department of Radio-diagnosis, SMVMCH for Magnetic resonance imaging in suspected focal lesions of prostate evaluation of focal prostatic lesions diagnosed in ultrasound.

Study duration: The duration of the study was about 15 months from the date of approval of the proposal.

Source of data: Patients who were referred to the Department of Radio-Diagnosis, Sri Manakula Vinayagar Medical College and Hospital for Magnetic resonance imaging of prostate with clinically suspected Prostatic lesions.

Inclusion criteria: All patients in whom focal prostatic lesions are clinically suspected and referred to Radio-diagnosis department for Magnetic resonance imaging of prostate

Exclusion criteria:

- Patients with only benign prostatic hyperplasia
- Patients with diffuse prostatitis
- Patients with prostatic abscess
- Pediatric population
- Patients who are already diagnosed of prostatic lesion and under treatment

Sample size: Considering the average number of cases with focal prostate lesions in the department of Radio-diagnosis, Sri Manakula Vinayagar Medical College and hospital reported during the last year as 24, all the patients who were fulfilling the inclusion criteria of the present study during the set study period of 15 months were taken into the study which was approximately 30 patients.

Sampling method: All cases referred for Magnetic Resonance Imaging-prostate, fulfilling the Inclusion and exclusion criteria were be considered for the study.

Instrumentation: Magnetic resonance imaging studies performed on 1.5 Tesla Intera PHILIPS whole-body MR systems using standard imaging body coil Fig 1 and 2.

Brief procedure: Patients who were fulfilling the inclusion criteria were considered for the study. After obtaining an informed consent from patients own language, any queries from the patients were cleared and information is collected by questionnaires. After obtaining the history, the patient was subjected to Magnetic Resonance Imaging following which the histopathological report obtained from the tissues was correlated along with the findings obtained from MRI.

MRI technique: Patient was explained the process of MRI scan. The patient was then subjected to T1 and T2

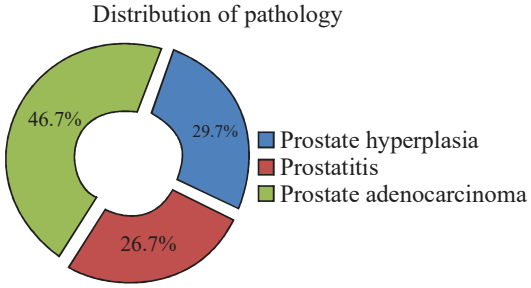

Figure 1: Distribution of pathology

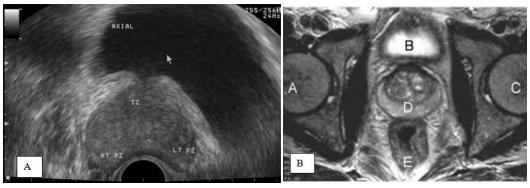

Fig. 2: Transrectalultra sound image in axial, showing normal prostate with the peripheral zone (PZ)and transitional zone(TZ); B: T2 axial image showing normal prostate anatomy; B-Bladder, E-Rectum, D- prostate

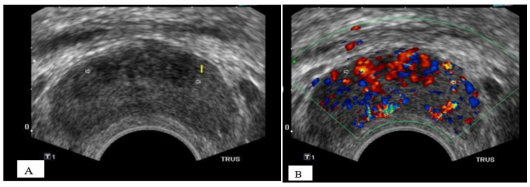

Fig. 3: A Acute prostatitis: Transrectal ultrasound axial image showing markedly hypoechoic patches in the inner zone of prostate which show; (B) increased vascularity of colour doppler

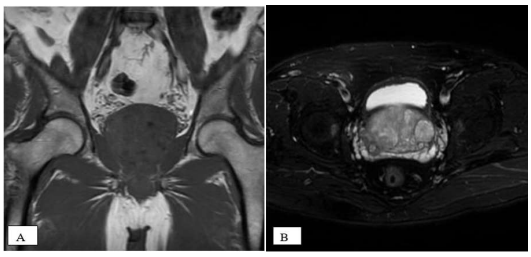

Fig. 4: T1 weighted coronal image shows enlarged heterointense prostate. B: STIR axial shows focal high signal intensity in the peripheral zone.

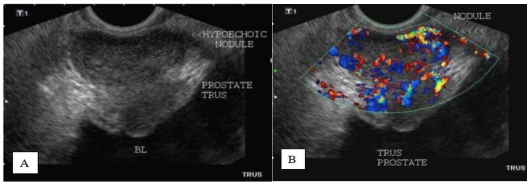

Fig. 5: A Prostatic adenocarcinoma: Transrectal ultrasound axial shows a hypoechoic lesion involving most of leftperipheral zone. B: Colour Doppler TRUS images reveals marked vascularity in the region of thenodule seen in the left peripheral zone.

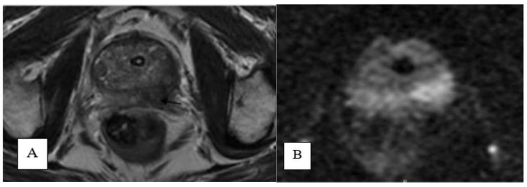

Fig. 6: Prostatic adenocarcinoma: Power Doppler images in transabdominal ultrasound reveal marked vascularity in the region of the nodule (left peripheral zone). There is also evidence of benign prostatic hypertrophy

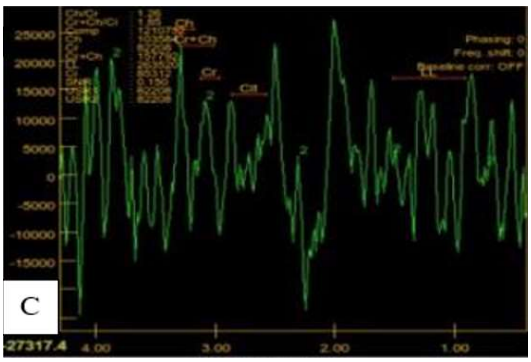

Fig. 7: Prostatic adenocarcinoma: Enlarged prostate with ill defined T2 weighted (A) hypointense lesion in the leftposterolateral aspect with diffusion restriction(B). MRS shows elevated choline and decreasedcitrate levels (C).

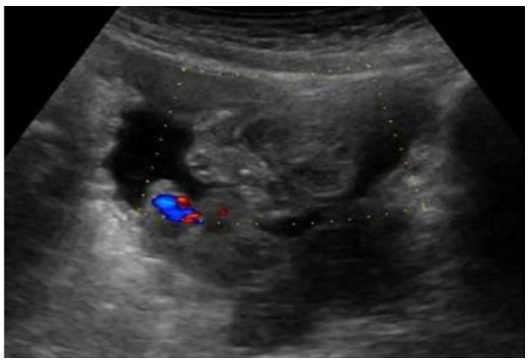

Fig. 8: Focal nodular BPH: STIR axial image shows an enlarged prostate gland with focal hyperintense nodule in the peripheral zone.

weighted sequence of MRI along with MR Spectroscopy (Table 1 and Fig 3)

Statistical analysis: Data was entered into Epi Info and was analyzed using SPSS 25 version software. Ordinal discontinuous variables were represented in the form

Fig. 9: Focal nodular BPH: T2 weighted coronal images typically demonstrates the enlarged central zone to be heterogenous in signal with an intact low signal pseudocapsule around its periphery.

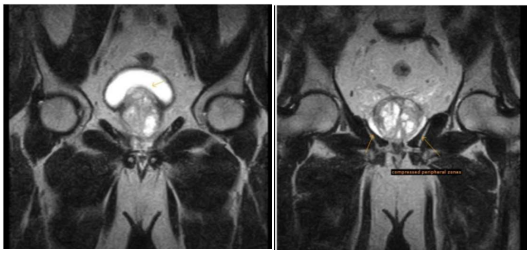

Fig. 10: Xanthogranulomatous prostatitis: T2 weighted axial (A) and coronal (B) images demonstrate enlarged irregular prostate gland with hypointense foci on T2 weighted images.

of frequencies and proportions. Discrete Continuous variables were represented as mean and standard deviation. The sensitivity, specificity, positive predictive value and negative predictive value of diffusion sequence was correlated with gold standard histopathology report.

Statistical software: MS Excel, SPSS version 25 was used to analyze data.

RESULTS

Age distribution: This study was conducted in the Department of Radiodiagnosis, SMVMCH from November-April 2019-2021. The study comprised of a total of 30 patients. Age of the patients ranged between 50-80 years with mean age of 67.5 years. Six patients (20%) were between 50-59 years, 10 patients (33.3%) between 60-69 years and 14 patients (46.7%) between 70-80 years. PSA level ranged between 8-87 ng mL with a mean level of 30.6 ng mL. PSA level was higher in older patients.

In our study population, 8 patients had benign hyperplasia involving the central zone (BPH) 14 patients had carcinoma and 8 patients had prostatitis (Table 2 and 4 and Fig 3 an 5).

Distribution of pathology by age group: Out of the different types of prostatic pathologies, patients having only BPH or carcinoma were noted to be more common in the more than 70 years of age groups, where as patients having prostatitis were more common in 50-59 years age.

Patients with prostatomegaly had higher PSA level than those with normal prostatic volume. PSA level in patients having carcinoma was higher than patients with BPH. Patients with prostatitis were also noted to have higher levels of PSA than patients having BPH however, their PSA values were less than inpatients having carcinoma (Table 5 and 6 and Fig 6 and 7).

Distribution of prostate hyperplasia within focal pin change: Out of the 8 patients who had benign prostatic hyperplasia, 6 patients had low grade focal PIN changes and 2 patients had high grade PIN changes.On T1 weighted images, prostatitis and prostatic hyperplasia were predominantly heterointense in signal intensity, whereas prostatic adenocarcinoma appeared predominantly isointense.

Out of the 8 patients with prostatic hyperplasia with focal PIN changes, 7 patients showed hypointense signal intensity on T2 weighted images. Seven out 8 patients with prostatitis showed hypointense signal intensity on T2 weighted images. Ten out of 14 patients with prostatic adenocarcinoma appeared heterointense on T2 weighted images (Table and Fig 4). Twelve patients showed hypointense foci (peripheral) on T2 weighted images in which 10 wereproven to be adenocarcinoma and the remaining 2 did not show adenocarcinoma foci on biopsy Fig 8 and 11. MRSI showed definite cancer foci (choline and creatinine peaks with reduced levels of citrate) in 12 of 30 patients. Two patients with MRSI features suggestive of cancer foci were negative on histopathology. Two patients who had a normal metabolic profile on MRSI were proved to have cancer on histopathology (Table and Fig 6). With results of histopathologic examination as reference standard, T2-weighted images detected 10 of 14 patients proved to have cancer on biopsy (Sensitivity 71.4%, Specificity 87.5% and Accuracy

Table 1: Pie diagram showing distribution of prostatic pathologies among study participants

Parameters	MRS pectroscope	T2 weighted imaging	T1 weighted imaging
Coil selection	Sense-body	Sense-body	Sense-body
TE	120 ms	120 ms	15ms
TR	1500 ms	shortest	Min-400 Max-600
MATrix	256-256	256-256	256-256
Slicethickness	3 mm	3 mm	3 mm
Section-spacing	1mm	1 mm	1 mm
FOV	180-180-71	180-180-71	180-180-71

Table 2: PSA levels in different prostatic pathologies

	PSA Levels	
Pathology	Mean	SD
Prostate hyperplasia	14.5	7.98
Prostatitis	22.1	15.18
Prostate adenocarcinoma	44.6	23.35

80.1 %) (Table and Fig 7). Fisher's Exact test showed p<0.004, which is highly significant. MRSI detected 12 out of 14 patients who proved have cancer on biopsy (Sensitivity 85.7 %, Specificity87.5%, accuracy 86.6%). Fisher's Exact test showed p<0.001, which is highly significant. MRSI was more sensitive and specific compared to T2-weighted images alone.

Patient with acute prostatitis had diffuse homogeneous hyperintensity involving both the central and the peripheral zone. Elevated levels of Cit with low levels of Cho+Cr were noted on MRSI in one patient with acute prostatitis. Patient with chronic prostatitis had focal non-nodular hypointensityon T2 Wimages. MRSI displayed elevated citand reduced Cho/Crlevelsin patients with chronic prostatitis.

DISCUSSIONS

The patients usually present with symptoms like weak streaming, incomplete voiding and increased frequency of micturition. Detection and clinical staging of prostate cancer by various lab and imaging modalities includes prostate specific-antigen (PSA) test, digital rectal examination, ultrasound and magnetic resonance imaging. MRI with MRS increases the accuracy of tumor detection and also helping in staging and thus helps in planning for specific treatment.This was a prospective study in the Department of Radio-Diagnosis, SMVMCH, Puducherry, aimed at studying the role of MRI and MRS in evaluation of prostatic pathologies. In our study population, out of 30 patients, 8 patients had benign hyperplasia (BPH) with focal PIN changes, 14 patients had adenocarcinoma, 8 patients had focal prostatitis.

Abdel-Meguid TA. *et al.* described their study with a number of 214 patients with median age of 68 years. Out of them, 88 showed inflammatory changes with one in that showed acute inflammation. Inflammation alone consisted of 5.6%, BPH included 58.9% and carcinoma included 35.5%. BPH and carcinoma associated with inflammatory changes. In our study, out of 30 patients evaluated with prostatic pathologies, 14 had malignant condition and 16 patients had non malignancy. Out of these, 14 (46.7%) had prostate carcinoma and 8 (26.7%) had benign prostatic hyperplasia. Remaining 26.7% showed inflammatory pathologies. These findings correlate well with the study by Abdel *et al.* In our study, mean age of the patient was 66.5±6.48 years which is correlating with the study by Abdel *et al*.[10].

Benign prostatic hyperplasia: Hricak *et al.* described in his study that peripheral zone showed higher signal intensity than that of central or peripheral zone. The study conducted in different TR and TE with different magnetic field. Central zone showed lower T2 signals in T2 weighted imaging. In our study, majority of patients with BPH had a heterogeneous appearance of the transitional zone on T2W MRI. The peripheral zone of the prostate was hyperintense when compared to the central zone on T2W MRI. These findings correlate well with the previously mentioned study[11].

In our study, PSA level ranged between 8-87 ng mL with a mean level of 30.6. PSA level was noted to be higher in older patients. Carcinoma was commoner in the 70-80 years, i.e the later age group. These findings correlated well with the previously mentioned study.

Prostatic carcinoma: Prostate cancer diagnosis with imaging includes TRUS and MRI. However, TRUS shows many false positive results and also it fails to detect as many as 8-30% of lesions which were palpable at DRE. So, MR imaging remains the best evaluation tool for prostate cancer and also to differentiate between the organ confined tumor and tumor with extracapsular extension.

Kurhanewicz *et al.* and Kurhanewicz *et al.* showed in many studies about the sensitivity and specifity of combined endorectal and phased-array coil which varies widely. Only T2 weighted imaging showed sensitivity and specificity of 22-85% and 50-99% respectively and MRS showed the sensitivity and specificity of 29-89% and 62-95%, respectively, by correlating these imaging data with the biopsy results[6,7].

In our study, 10 out of 14 patients with prostatic carcinoma presented with nodular heterogenous hypointensity in the peripheral zone on T2W MRI. This finding correlated well with the previous mentioned study.

Sophie Riches *et al.* has found that non tumoral tissue is having increased Cit/Cho ratio whereas, tumoral tissue had increased choline in the peripheral zone (p = 0.007) and in the central gland (p = 0.005)[12]. Sahibzada *et al.* showed in his study that for the detection of carcinoma the sensitivity of MRI was 67 % (95 % CI 38-87 %) and specificity was 85 % (CI 76-92 %). The PPV value was 76 % and NPV was 51 %. The positive and negative likelihood ratios were 2.5 and 0.7, respectively[13]. Sensitivity and specificity of T2W MRI in our study was comparable to that demonstrated by Scheidler *et al.*[63]. Sensitivity and specificity of MRSI in our study was comparable to that demonstrated by Tom Scheenen*et al.*[14]. There were 2 false positive instances of carcinoma on T2-weighted images. Out of these 2 patients, 1 patient had features of chronic prostatitis and 1 had features of false positive instances of carcinoma on T2-weighted

Table 3: Comparison of results of MRS with biopsy results

	Prostate hyperplasia with focal PIN change		
Comparison of MRS with prostate hyperplasia with PIN change	Low grade	High grade	Total
Citrate high	1	0	1
Citrate low	5	2	7
Total	6	2	8

Table 4: Comparison of MRS with prostate adenocarcinoma

	HPE prostate adenocarcinoma		
MRS	Positive	Negative	Total
Citrate high	12	2	14
Citrate low	2	4	16
Total	14	6	30

Table 5: Diagnostic ability of MRS in prostate adenocarcinoma

MRS vs HPE prostate adenocarcinoma	Percentage
Sensitivity	85.7
Specificity	87.5
Positive predictive value	85.7
Negative predictive value	87.5

Table 7: Diagnostic ability of T2 weighted imaging in prostate adenocarcinoma

T2 WI vs HPE prostate adenocarcinoma	Percentage
Sensitivity	71.4
Specificity	87.5
Positive predictive value	83.3
Negative predictive value	77.8

images. Out of these 2 patients, 1 patient had features of chronic prostatitis and 1 had features of benign prostatic hyperplasia on biopsy. This can be due to confounding effect of chronic prostatitis on T2 W imaging, various histological component of the nodule and biopsy not obtained from the lesion[8]. Four false negative cases for carcinoma were also seen in T2W imaging which can be due to the small size of lesion, lower gleason grade of tumor or low SNR of images. MRSI showed higher sensitivity, specificity and accuracy compared to T2W imaging. Two patients were false positive for carcinoma. This difference can be attributed to confounding effect of prostatitis or biopsy not obtained from the lesion. Two cases were false negative for carcinoma in which one had chronic prostatitis and one had BPH which can be due to confounding effect or small size of lesion or low gleason grade of tumor[8].

Prostatitis: Yoon-Soo Kyung *et al.* have done study based on 107 patients who had come with complaints of lower urinary tract symptoms. Mean size of prostate and total PSA levels were assessed. They found that both PSA level and size of the prostate were increased in the study patients but it came to normal level within 8 weeks. In our study the mean prostate size in prostatitis patients was 46 cc and their mean PSA level was 7.1 ng mL. Patients with benign and malignant conditions, both had elevated PSA levels and prostate volume. These findings correlate well with the previously mentioned study[9]. Cheng *et al.* showed in his studies that, out of 6 patients of prostatitis in his studies, 2 showed nodular (33%) and 4 showed diffuse lesions (67%) were seen on MRI. T2W imaging showed hypointensity in nodular even in diffuse lesion but higher than that of muscle. Some of these diffuse lesions showed increased signal in DWI and decreased signal in ADC [16].

In our study, T2W MRI and MRSI were able to diagnose acute prostatitis accurately. However, T2W MRI findings of chronic prostatitis were overlapping with that of carcinoma.

CONCLUSION

T2W MRI and MR spectroscopy have a great sensitivity for detecting and distinguishing organ-restricted prostate cancer from other benign causes. MR spectroscopy is more sensitive and specific than MRI alone, hence recommended for combined imaging with MRI and MR spectroscopy.

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