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Accuracy of Multi-Parametric MRI in Prostate Cancer Diagnosis

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ABSTRACT

Background: When it comes to male cancers, prostate cancer is the second most common malignancy on a global scale. A transrectal ultrasound-guided biopsy (TRUS-biopsy) could be performed to diagnose prostate cancer in men who have an elevated blood prostate specific antigen (PSA). **Objective:** To determine whether males with elevated PSAs might safely forego unnecessary biopsy by using multi-parametric magnetic resonance imaging (MP-MRI) as a triage test. **Patients and Methods:** The study was conducted at Badr University Hospital and Nasr-City Health Insurance Hospital on 60 patients with clinical suspicion of prostate cancer. The duration of the study was 12 months. **Results:** The Multi-parametric MRI findings recorded; 10% of patients had prostatitis, 65% had prostatic cancer and 25% had benign prostatic hyperplasia (BPH). Regarding TRUS-biopsy findings, 60% of the patients were positive for cancer prostate, and 40% of the population were negative. The mean serum (PSA) for the patients was 12.34 (ng/mL) with SD 2.98. The MP-MRI was able to correctly identify 33 out of 36 patients with carcinoma (when the comparison is made with the (TRUS-biopsy). It could also exclude 18 out of 24 patients without carcinoma when compared to the biopsy. The sensitivity of MP-MRI was 91.7 %, specificity was 75%, positive predictive value (PVP) was 84.6 % and negative predictive value (PVN) was 85.7%. There was moderate agreement between both techniques (k= 0.68). **Conclusion**: Using multi-parametric MRI could lead to a decrease in needless biopsies and an increase in the number of clinically meaningful prostate cancer diagnoses, perhaps preventing overdiagnosis and overtreatment.

Keywords: Prostate specific antigen, Multi-parametric magnetic resonance imaging, Transrectal ultrasound biopsy.

INTRODUCTION

The second most common malignancy in men worldwide is prostate cancer [1]. Transrectal ultrasound-guided biopsy is a step in the diagnostic route for prostate cancer for men who show elevated serum PSA levels. This leads to the unnecessary removal of healthy tissue from many men, the detection of cancers that aren't serious enough to warrant further investigation, and the occasional omission of tumors that are serious enough to warrant further investigation [2]. Furthermore, TRUS-biopsy is associated with an increased risk of morbidity and even death due to sepsis [3].

The limitations of transrectal ultrasonography guided prostate biopsy as a standalone diagnostic tool are increasingly apparent, despite the fact that it remains the most often used approach for identifying prostate cancer. One peculiarity of TRUS-biopsy is that it cannot detect cancer by visual or imaging signals since it cannot localize the tumor. Men suspected of having prostate cancer have been wrongly identified due to the unguided deployment of needles [4]. Several issues render the current technique unsustainable. These include the frequently voiced concerns about unnecessary medication resulting from overdiagnosis of minor tumors, the missed detection of essential cancers, and the danger of infection ranging from 2-4%, some of which can be deadly [5].

It is possible to boost diagnosis accuracy while decreasing the number of unnecessary biopsies by using imaging as a triage test to identify which men with elevated PSA should undergo the surgery. In addition to revealing anatomical details, multi-parametric MRI can reveal tissue characteristics like cellularity, vascularity, and prostatic volume. As a possible triage test, MP-MRI is appealing because there is some evidence that it often misses low-risk disorders while detecting higher-risk ones [6, 7].

We aimed in this research to determine whether MP-MRI may be utilized as a screening tool to avoid conducting needless biopsies on men who have a high PSA.

PATIENTS AND METHODS

This was a prospective interventional study that was conducted at Badr University Hospital and Nasr-City Health Insurance Hospital.

Sample size: The attendance rate of suspected prostate cancer with PSA > 4 ng/ml is 5 cases/ month so, the total number of cases is (60 patients) as a comprehensive sample. The duration of the study was 12 months.

Inclusion criteria:

Men who had never undergone a prostate biopsy before but were encouraged to do so due to clinical suspicions that they may have prostate cancer, such as a suspicious digital rectal examination or increased serum PSA levels over 4 ng/mL in two separate tests. Patients were over the age of forty. There was no reason to avoid spinal or general anesthesia. It was safe to use MP-MRI.

Exclusion criteria:

Patients were excluded if they: At the time of recruiting or within the preceding six months, took 5-alpha-reductase inhibitors. Known a patient's medical history that included prostate cancer therapy, BPH therapies, or surgery for prostate cancer. In the past three months, they had acute prostatitis or urinary tract infection symptoms, had a history of hip replacement surgery, had metallic hip replacement, or substantial pelvic orthopedic metal work. Were also unable to get an MRI

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due to claustrophobia, a pacemaker, or an estimated glomerular filtration rate of less than or equal to 50. Exhibited symptoms of a bleeding condition.

Procedure: When patients were admitted, the following information was gathered from them: A thorough medical history that included the patient's current condition, past medical history (including name, age, and profession). The patient's medical history, including diabetes and hypertension, prostate cancer in the family tree. A clinical evaluation that centers on: Comprehensive test: Pallor, cyanosis, jaundice, and enlarged lymph nodes are symptoms that should be noted with vital signs such as blood pressure, temperature, heart rate, and respiratory rate. Test for prostate cancer: For the purpose of measuring and inspecting for abnormalities such as lumps, soft or hard areas, and so on.

All enrolled patients were subjected to MP-MRI then TRUS-biopsy.

Test 1: MP-MRI (index test)

The first step was for patients to have an MP-MRI that was standardized according to the guidelines established by the European Society of Uro-Radiology. A 1.5 Tesla magnetic field and a pelvic phased-array coil were used in this MRI. All sorts of variations were documented, including dynamic gadolinium contrast-enhanced imaging sequences, T1-weighted, T2-weighted, diffusion-weighted, and others.

Tests 2: TRUS-biopsy:

After the MP-MRI examination was done successfully, prostate biopsy procedure was done within one month of the imaging study. Biopsy was guided by transrectal ultrasound, under local, general, or spinal anesthesia. Each core was identified and processed independently in the standard test (TRUS-biopsy), which follows international standards for core biopsies. An experienced pathologist obtained the TRUS-biopsy samples and sent them for analysis.

Technique:

The 18-gauge needle was guided by a biopsy attachment and driven by a spring-loaded biopsy cannon to obtain longitudinal biopsies. Every patient received a pre-examination enema and a three-day course of 400 mg of norfloxacin as a preventative measure. The initial dosage was administered one hour prior to the test. Uneven echogenicity, hypoechoic or hyperechoic lesions of varying degrees of definition, and a lack of clarity at the boundary between the surgical capsule's peripheral and transition zones were all indicators of possible malignancy.

Twelve systematic biopsy samples were collected, their sizes determined by the glands' dimensions. Artifacts were collected from the gland's base (BP), middle (M/M), apex (AP), and middle (M/L). Each lobe's anterior transition zone (TZ) was sampled once for biopsies when the longitudinal length surpassed 4 cm. Before firing the gun, the needle was inserted at least 1 cm into the prostatic tissue for these biopsy samples, which were positioned close to the midline. When lesions thought to be prostate cancer were not part of the systematic pattern sampling, extra samples were taken from those areas.

Ethical approval:

The study was approved by the Ethics Committee of the Faculty of Medicine at Helwan University. A detailed description of the study's objectives was given to each participant before they completed an informed consent form. The Helsinki Declaration was adhered to at every stage of the investigation.

Statistical analysis

The following is a rundown of the steps used to gather, tabulate, and analyze the data statistically using the SPSS version 22.0 statistical package: Coding and editing and keyboarding on a computer. The mean plus or minus the standard deviation was used to represent quantitative data, whereas frequencies and relative percentages were used to represent qualitative data. The degree of agreement between the two approaches was calculated using the kappa agreement (k) value. Sensitivity, specificity, accuracy, PPV, and NPV were used to assess the MP-MRI's validity. A significant p-value was defined as one that is equal to or less than 0.05.

RESULTS

Regarding demographic data, the mean age was 66.8 years. 33.33% of the population had a past medical history of urologic disease, and 30% had a family history of prostate cancer. Most of the patients were smoking (Table 1).

Table (1): Demographic data and history among the studied group.

	Patients (N=60)
Age (years) Mean ± SD	66.8± 11.32
	No. (%)
Past medical history of urologic disease	20 (33.33%)
Past surgical history of urologic disease	16 (26.67%)
History of smoking	51 (85 %)
Family history of prostate cancer	18 (30%)

The mean systolic/diastolic blood pressure was 124.3/78.13 mmHg, the mean pulse rate was 99.41/minute, the mean temperature was 37.03, the mean respiratory rate (RR) was 14.95 breaths/minute, and the mean of oxygen saturation was 96.38 % (Table 2).

Table (2): Vital data among the studied group.

	Patients (N=60) Mean ± SD
SBP (mmHg)	124.3±8.65
DBP (mmHg)	78.13±10.38
Pulse	99.41±13.35
Temperature	37.03±0.38
RR (breaths per min)	14.95±2.45
Oxygen saturation	96.38± 2.31

The mean serum prostate specific antigen (PSA) is shown in table 3.

Table (3): Serum prostate specific antigen among the studied group.

	Patients (N=60) Mean ± SD
PSA (ng/mL)	12.34±2.98

Multi-parametric MRI finding among the studied group revealed that 65% of patients had prostatic cancer (Table 4).

Table (4): Multi-parametric MRI finding among the studied group.

	Patients (N=60) No. (%)
Prostatitis	6 (10 %)
Prostatic adenocarcinoma	39 (65 %)
BPH	15 (25 %)

Regarding the TRUS-biopsy finding in the studied group, 60% of the patients were positive (Table 5).

Table (5): TRUS biopsy finding among the studied group.

	Patients (N=60) No. (%)
Positive for cancer prostate	36 (60%)
Negative for cancer prostate	24 (40%)

The MP-MRI was able to correctly identify 33 out of 36 patients with carcinoma (when the comparison is made with the TRUS-biopsy). It could also exclude 18 out of 24 patients without carcinoma when compared to the biopsy. There was moderate agreement between both techniques (k= 0.68) (Table 6).

Table (6): Validity of MP-MRI in diagnosis of prostate cancer in comparison to TRUS-biopsy:

MP-MRI	Biopsy		Total	P	K
	Positive	Negative			
Positive	33	6	39	< 0.001	0.68
Negative	3	18	21		
Total	36	24	60		
Sensitivity= 91.7%			Specificity:75 %		
PPV: 84.6 %			NPV: 85.7%		
Accuracy: 85 %					

DISCUSSION

This research set out to determine whether MP-MRI may be used to prioritize which males with a high PSA level should not have an unnecessary biopsy. Nasr-City Health Insurance Hospital and Badr University Hospital were the sites of the research.

Thompson *et al.* [8] found a mean age of 62.4 years for men older than 40 with abnormal prostate specific antigen/digital rectal examination. The purpose of their prospective study was to determine the accuracy of multi-parametric MRI in detecting significant prostate cancer in men with abnormal PSA/digital rectal examination before diagnostic biopsy. The results were similar to ours, with a mean age of 66.8 years and a standard deviation of 11. 32.

Connected to this is the work of **Arumainayagam *et al.*** [9], the goal of which was to ascertain whether or not multi-parametric MR imaging could detect clinically significant prostate cancer and to assess the diagnostic performance of this imaging modality compared to transperineal template prostate mapping (TTPM) biopsies. The research involved 64 males, with an average age of 62 years (ranging from 40 to 76) and an average prostate-specific antigen level of 8.2 ng/mL (ranging from 2.1 to 43 ng/mL).

In line with **Ahmed *et al.*** [10], the purpose of this study was to determine if MP-MRI could distinguish between individuals who had and did not have clinically relevant prostate cancer using a reference test called template prostate mapping biopsy (TPM-biopsy). Because TPM-biopsy samples the whole prostate at 5-mm intervals, it correctly characterizes disease status in at-risk individuals. Additionally, they planned to evaluate MP-MRI's precision in relation to TRUS-biopsy. Our patient's age (66.8 years) was quite similar to theirs.

Regarding our findings for serum prostate specific antigen among the studied group, the mean PSA was 12.34 ng/mL with SD 2.98, which was slightly higher than **Arumainayagam *et al.*** [9] who demonstrated that the mean PSA of their studied patients was 8.2 ng/mL [range, 2.1–43 ng/mL]). And, higher than **Thompson *et al.*** [8], who demonstrated that the mean of PSA was 5.6 ng/mL.

MP-MRI was able to correctly identify 33 out of 36 patients with carcinoma (when the comparison was made with the TRUS-biopsy). It could also exclude 18 out of 24 patients without carcinoma when compared to the biopsy, with sensitivity of 91.7 %, specificity of 75%, PVP of 84.6 % and PVN of 85.7%. There was moderate agreement between both techniques (k= 0.68).

A recent systematic analysis from Europe by **Moldovan *et al.*** [11] found similar results for MP-MRI NPV for overall prostate cancer (CaP) and clinically significant prostate cancer (csCaP), respectively, with 82.4% and 88.1% (range 85.7-92.3%). While NPV declines with increasing cancer prevalence, the authors note that this trend is conditional on both the cancer prevalence rate and the specific definition of csCaP.

In 2017, **Ahmed *et al.*** [10] examined 576 men who participated in the UK prostate MRI Imaging Study (PROMIS). The researchers found that MP-MRI had a sensitivity of 93% (95% CI 88-96%) for clinically significant malignancy and a NPV of 89% (83-94%). The PVP of MP-MRI was 51% (46-56%), and its specificity was 41% (36-46%). Out of 576 men, 158 (or 27%) had a negative MP-MRI. Among these, 17 had TPM-biopsy results indicating clinically significant malignancy. The sensitivity of MP-MRI was 93% compared to TRUS-biopsy's 48%, and the NPV was 89% compared to 74%. The specificity of TRUS-biopsy was 41% higher than 96% ($p<0.0001$), and its PVP was 51% higher than 90% ($p<0.0001$). In terms of detecting Constitute of Clinically Significant Prostate Cancer (Cs CaP), they found that MP-MRI was more sensitive than TRUS biopsy, although it was not as specific.

As an additional point, we agreed with **Thompson *et al.*** [8], who showed that 66% of patients had positive results from multi-parametric MRI, 61% had prostate cancer, and 30% to 41% had highly significant prostate cancer. The sensitivity ranged from 93% to 96% for serious cancer, the specificity from 47% to 53%, and the NPV from 92% to 96% and the PVP from 43% to 57%, respectively.

With an abnormal prostate specific antigen/digital rectal examination preceding diagnostic biopsy, **Thompson *et al.*** [12] aimed to assess the dependability of multi-parametric MRI in identifying substantial prostate cancer in men. Only 344 out of 388 male participants were able to have their data examined. Multi-parametric MRIs were positive in 77.0% of patients, 62.5% of men had prostate cancer, and 41.6% of men had a highly advanced stage of the illness. Serious prostate cancer may be detected with 96% sensitivity, 36% specificity, 92% NPV, and 52% PVP using MP-MRI. The multivariate model, which previously contained prostate specific antigen, digital rectal examination, prostate volume, and age, saw an improvement in the area under the curve (AUC) from 0.776 to 0.879 ($p <0.001$) with inclusion of the Prostate Imaging Reporting and Data System (PI-RADS). There was a bit of discrepancy between the regions indicated as positive on MRI and those discovered during the biopsy (4 [2.9%]), even though there was a tiny quantity of prostate cancer in the specimen collected during radical prostatectomy (3.3% of the total).

Branger *et al.* [13] compared the radical prostatectomy result to the preoperative negative MP-MRI and found that the former did not necessarily indicate the absence of clinically relevant cancer. Following surgery, 60.4% of patients experienced unfavorable pathology.

Komai *et al.* [14] combined the results of transrectal 12-core and transperineal 14-core biopsies into a 3-dimensional 26-core prostate biopsy in an effort to elucidate the diagnostic capacity of multi-parametric MRI to detect anterior cancer that transrectal 12-core biopsies missed. A similar goal was pursued by this research. Their trial had around 324 participants. The authors found that out of 324 cases of prostate cancer, 39% (128/324) were transrectal 12-core negative, while 28% (36/128) were not. Prebiopsy multi-parametric MRI revealed an anterior lesion in 65 out of 324 males, or 20% of the total. Among the males who had imaging and did not show an anterior lesion, 3.8% (10 out of 259) had transrectal 12-core negative malignancy, while 40% (26 out of 65) did not. Out of 259 males, 0.4% had significant transrectal 12-core negative cancer, even though imaging showed no anterior lesion. Of the 12 cases of substantial transrectal 12-core negative cancer, 92% (11 out of 12) were found to have an anterior lesion on prebiopsy MP-MRI. In addition to the benefits of transrectal 12-core prostate biopsies, they found that prebiopsy multi-parametric MRI could help identify men who would benefit from anterior samplings.

According to **Arumainayagam *et al.*** [9], when it comes to detecting males at risk for prostate cancer, MP-MR imaging has a high NPV for excluding clinically relevant cases. **Bjurlin *et al.*** [15] came to a similar conclusion, stating that conventional prostate biopsies can have their sample errors reduced by using MRI to enhance disease localization and sampling.

CONCLUSION

MP-MRI has the potential to minimize the number of needless biopsies while increasing the frequency of diagnoses of clinically relevant prostate cancer, according to the literature. This could lead to a decrease in overdiagnosis and overtreatment.

To aid in tumor diagnosis, biopsy guiding, and treatment planning, MP-MRI is now commonly utilized in many practices as a safe imaging technique for prostate cancer evaluation. Its broad adoption, however, is still contingent upon ongoing technical optimization and other potential investigations.

RECOMMENDATIONS

In order to validate these findings, larger-scale investigations are required. We need more trials with longer follow-up lengths if MP-MRI may be used as a triage test to find out which men with an increased PSA can safely avoid unnecessary biopsies. Randomized controlled trials that are well-designed should be used to perform future studies.

LIMITATIONS

Hospital Based Study: The research was conducted at Badr University Hospital and Nasr-City Health Insurance Hospital, limiting the generalizability of findings to a broader population. Sample Size: The study's sample size of 60 patients, necessitating caution in extrapolating results.

No funding.

No conflict of interest.

REFERENCES

1. **Torre L, Siegel R, Ward E *et al.* (2016):** Global cancer incidence and mortality rates and trends—an update. Cancer Epidemiol Biomarkers Prev., 25:16–27.
2. **Caverly T, Hayward R, Reamer E *et al.* (2017):** Presentation of benefits and harms in US cancer screening and prevention guidelines: Systematic review. J Natl Cancer Inst., 108: djv436. doi: 10.1093/jnci/djv436.
3. **Abraham N, Mendhiratta N, Taneja S (2015):** Patterns of repeat prostate biopsy in contemporary clinical practice. J Urol., 193: 1178-1184.
4. **Loeb S, Vellekoop A, Ahmed H *et al.* (2013):** Systematic review of complications of prostate biopsy. Eur Urol., 64: 876-892.
5. **Grey A, Ahmed H (2017):** The PROMIS trial – time for multi-parametric MRI before a first prostate biopsy. Urology News, 21 (3): 7897. https://www.urologynews.uk. com/media/7897/uroma17-promis-new.pdf.
6. **Turkbey B, Brown A, Sankineni S *et al.* (2016):** Multiparametric prostate magnetic resonance imaging in the evaluation of prostate cancer. CA Cancer J Clin., 66(4): 326–336.
7. **Valerio M, Donaldson I, Emberton M *et al.* (2015):** Detection of clinically significant prostate cancer using magnetic resonance imaging-ultrasound fusion targeted biopsy: a systematic review. Eur Urol., 68: 8–19.
8. **Thompson J, Moses D, Shnier R *et al.* (2014):** Multiparametric magnetic resonance imaging guided diagnostic biopsy detects significant prostate cancer and could reduce unnecessary biopsies and over detection: a prospective study. The Journal of Urology, 192(1): 67-74.
9. **Arumainayagam N, Ahmed H, Moore C *et al.* (2013):** Multiparametric MR imaging for detection of clinically significant prostate cancer: a validation cohort study with transperineal template prostate mapping as the reference standard. Radiology, 268(3): 761-769.
10. **Ahmed H, Bosaily A, Brown L *et al.* (2017):** Diagnostic accuracy of multi-parametric MRI and TRUS biopsy in prostate cancer (PROMIS): a paired validating confirmatory study. The Lancet, 389(10071): 815-822.
11. **Moldovan P, Van den Broeck T, Sylvester R *et al.* (2017):** What is the negative predictive value of multiparametric magnetic resonance imaging in excluding prostate cancer at biopsy? A systematic review and meta-analysis from the European Association of Urology Prostate Cancer Guidelines Panel. European Urology, 72(2): 250-266.
12. **Thompson J, Van Leeuwen P, Moses D *et al.* (2016):** The diagnostic performance of multiparametric magnetic resonance imaging to detect significant prostate cancer. The Journal of Urology, 195(5): 1428-1435.
13. **Branger N, Maubon T, Traumann M *et al.* (2017):** Is negative multiparametric magnetic resonance imaging really able to exclude significant prostate cancer? The real-life experience. BJU International, 119(3): 449-455.
14. **Komai Y, Numao N, Yoshida S *et al.* (2013):** High diagnostic ability of multiparametric magnetic resonance imaging to detect anterior prostate cancer missed by transrectal 12-core biopsy. The Journal of Urology, 190(3): 867-873.
15. **Bjurlin M, Meng X, Le Nobin J *et al.* (2014):** Optimization of prostate biopsy: the role of magnetic resonance imaging targeted biopsy in detection, localization and risk assessment. The Journal of Urology, 192(3): 648-658.