Diagnostic Performance of Prostate Multiparametric Magnetic Resonance Imaging in African-American Men

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OBJECTIVE To compare test performance of multiparametric magnetic resonance imaging (mpMRI) for detection of prostate cancer (PCa) in African-American men (AAM) and white men (WM) using the Prostate Imaging Reporting and Data System in unmatched groups as well as a cohort matched for clinical factors.

METHODS We examined our database of men who underwent prostate mpMRI prior to biopsy between October 2014 and June 2017 ($n = 601$; 60 AAM, 541 WM). Test performance was defined using Prostate Imaging Reporting and Data System classification 4 or 5 considered test positive and Gleason grade group 2 or greater from any biopsy core considered outcome positive. A subset analysis was performed using a propensity score caliper matching algorithm to match AAM to WM in a 1:2 ratio using the variables age, PSA, and PSA density.

RESULTS No significant differences in test performance were found with similar sensitivity (86.7% vs 83.6, $P = 1.00$), specificity (45.9% vs 49.1%, $P = .71$), positive predictive value (50.0% vs 46.9%), and negative predictive value (85.0% vs 84.8%, $P = 1.00$) for AAM and WM. Similar results were noted in our matched comparison. The rate of upgrading between targeted and systematic biopsy cores did not statistically differ between AAM and WM in both unmatched (12.2% vs. 15.8%, $P = .66$) and matched (12.2% vs 12.8%, $P = .92$) comparisons.

CONCLUSION Our findings provide supporting evidence that AAM have similar outcomes to WM in PCa detection using mpMRI. We suggest that mpMRI should not be withheld or offered preferentially on the basis of race when used for the detection of PCa. UROLOGY 134: 181−185, 2019.

In the United States, African-American men (AAM) have a higher incidence of prostate cancer (PCa), tend to have more advanced disease at presentation, and have a higher likelihood of death when compared to white men (WM).[1] The underlying causes of these discrepancies are complex, multifactorial, and incompletely understood.[2] While socioeconomic status and unequal access to care almost certainly play a role, AAM seem to carry increased risk for PCa even when accounting for these factors.[3]

As increasing evidence supports the use of multiparametric magnetic resonance imaging (mpMRI) as well as MRI with ultrasound (MRI-US) fusion biopsy techniques for PCa detection,[4] the utilization of mpMRI, and MRI-US fusion biopsy has increased rapidly.[5] Despite these significant, ongoing changes in the diagnostic pathway for PCa, little data currently exists demonstrating the effectiveness of such tools specifically in AAM. Further investigation of this technology with specific focus on this well-known high-risk group is indicated.

We sought to compare the outcomes of mpMRI and targeted MRI-US fusion biopsy in AAM as compared to WM at our institution.

METHODS

With Institutional Review Board approval, we reviewed our institutionally maintained prostate mpMRI database and identified 601 men who underwent prostate mpMRI prior to biopsy between October 2014 and June 2017. We identified 60 AAM and 541 WM for further analysis.

mpMRI Technique

Specific description of our institutional prostate mpMRI technique has been published previously.[6] Briefly, all patients underwent 3-Tesla mpMRI using a pelvic phased-array coil on Siemens Trio and Skyra platforms (Siemens Healthcare, Erlangen, Germany). High-resolution turbo spin echo T2-weighted images consisted of 3-mm slice thickness, small field of view imaging (160 mm) with a matrix of 512 × 512 for axial imaging

Conflicts of Interest: *None.*

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and 640 × 640 for coronal imaging. The small field of view diffusion-weighted imaging sequence initially consisted of 3 *b* values: 50, 500, and 1000 with a matrix of 128 × 128 and 3-mm slices, and more recently *b* values of 50 and 800 with a calculated *b* value of 1400. ADC maps were generated by the scanner. Dynamic contrast enhancement sequences consisted of 3D gradient recall echo T1-weighted imagines with a temporal resolution of 6-8 seconds, imaged initially over 6 minutes, later shortened to 2 minutes, with a matrix of 256 × 256 and 3-mm slice thickness.

mpMRI Interpretation

The Prostate Imaging Reporting and Data System (PI-RADS) version 1 was implemented at our institution in September 2014, followed by PI-RADS version 2 in February 2015.[7] Although there are differences between the earlier and current scoring systems, recent studies have shown excellent inter-reader agreement for both scoring systems.[8] Prostate volume was routinely measured using the semiautomated 3D segmentation feature of DynaCAD (Invivo Corporation, Gainesville, FL). Prostate mpMRI at our institution were read as part of the clinical workflow for the abdominal imaging section; 9 attending radiologists with an average of 11 years clinical experience after training; and approximately 80 prostate mpMRI per year interpreted the studies. Radiologists had access to all available clinical data in the patient chart at the time of interpretation, including previous biopsy results.

Biopsy Technique

For patients with PI-RADS classification 3 or greater lesions, software MRI-US fusion targeted biopsy as well as standard 12-core systematic template biopsy was performed using the UroNav platform (Invivo Corporation, Gainesville, FL). The MRI-targeted biopsies included 3-4 cores at each lesion, based on lesion size. For patients with PI-RADS classification 1 or 2, a standard 12-core systematic template biopsy was performed.

Statistical Analysis

Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated for mpMRI detection of clinically significant PCa. PI-RADS classification 1-3 was considered test negative while PI-RADS 4-5 was considered test positive consistent with PI-RADS assessment category specifications.[7] Biopsy Gleason grade group 1 versus Gleason grade group 2 or greater was considered condition negative versus condition positive, respectively. Wilcoxon rank-sum tests were used for continuous comparisons. Chi-square tests of independence and Fisher's exact test was used for categorical comparison. *P* values less than .05 were considered statistically significant.

A subset analysis was performed on all observations with PSA less than 50. Using this a subset, a propensity score caliper matching algorithm was used to match 58 AAM to 115 WM in a 1:2 ratio with the variables age, PSA, and PSA density.[9] All analyses were performed with R version 3.5.2.

RESULTS

The characteristics of the 601 patients included in our comparison are shown in Table 1. Our AAM cohort was noted to be younger (average age 62.7 vs 65.2 years, $P = .01$) and have a higher mean PSA (10.1 vs 8.7 ng/mL, $P = .01$) than our WM cohort. PSA density (0.19 vs 0.18 ng/mL^2, $P = .32$), abnormal digital rectal exam (DRE) (16.7% vs 15.2%, $P = .71$), and documented family history of PCa (28.3% vs 28.3%, $P = .99$) were similar for both AAM and WM. The study population included men who were previously biopsy naïve, men with prior negative biopsy, and men who were on active surveillance protocols. The difference in biopsy indication between the 2 groups did not reach statistical significance ($P = .31$). The characteristics of the 173 patients included in our matched comparison are also described in Table 1. Average age (62.6 vs 61.9 years, $P = .79$), PSA (9.3 vs 8.1 ng/mL, $P = .11$), and PSA density (0.19 vs 0.16 ng/mL^2, $P = .55$) were similar in this subset.

Table 2 lists mpMRI and biopsy characteristics by race. Overall, 500 patients in the unmatched cohort (51 AAM, 449 WM) had a lesion noted on mpMRI of at least Prostate Imaging Reporting and Data System (PIRADS) classification 3 with 377 (40 AAM, 237 WM) having a PIRADS 4 or 5 lesion. Distribution of highest PIRADS lesion did not differ between races ($P = .97$). Total 158 patients (17 AAM, 142 WM) had more than 1 lesion noted on mpMRI. Lesion location was similar between AAM and WM with 398 patients having lesions only noted in the peripheral zone (65.0% vs 66.4%), 105 having lesions only in the transition zone (23.3 vs 16.8%), and 23 having lesions in both peripheral and transition zone (0% vs 4.3%, $P = .27$). Anterior vs posterior location of mpMRI lesions was also noted to be similar with 139 patients having anterior lesions (20.0% vs 23.5%) and 387 having posterior lesions (68.3% vs 64.0%, $P = .79$). At biopsy, 212 patients (35.3%) were found to have clinically significant PCa with no statistically significant difference noted between AAM and WM (38.3% vs 34.9%, $P = .60$). Nearly half of patients (46.3%) included in the study did not have histologically confirmed PCa. Our matched cohort demonstrated similar findings for both AAM and WM in distribution of lesion classification ($P = .86$), number of lesions ($P = .44$), lesion zonal location ($P = .43$), anterior vs posterior location ($P = .61$), and detection of clinically significant cancer ($P = .91$) as illustrated in Table 2.

When comparing performance parameters for high suspicion mpMRI lesions (ie PIRADS classification 4 and 5) indicating the presence of clinically significant PCa, no significant differences were noted between AAM and WM, with similar sensitivity (86.7% vs 83.6, $P = 1.00$), specificity (45.9% vs 49.1%, $P = .71$), positive predictive value (50.0% vs 46.9%), and negative predictive value (85.0% vs 84.8%, $P = 1.00$) as listed in Table 3. For the patient with PIRADS classification 3-5 lesions, the rate of upgrading between targeted and systematic biopsy cores did not statistically differ between AAM and WM (12.2% vs 15.8%, $P = .66$). Similar findings were noted in our matched comparison with sensitivity (86.4% vs 80%, $P = .73$), specificity (44.4% vs 49.3%, $P = .63$), positive predictive value (48.7% vs 45.7%, $P = .76$), negative predictive value (84.2% vs 82.2%, $P = 1.00$), and upgrading rates (12.2% vs 12.8%, $P = .92$) all being similar between AAM and WM.

DISCUSSION

In this study, we sought to determine if clinically significant PCa detection outcomes were similar for AAM and WM when prostate mpMRI was used prior to combined targeted and systematic prostate biopsy. We found that mpMRI showed similar test performance (ie sensitivity, specificity, PPV, and NPV) for both racial groups in an unmatched cohort as well as in a cohort matched for

Table 1. Patient characteristics

Characteristic	Unmatched AAM (N = 60)	Unmatched WM (N = 541)	Unmatched P	Matched AAM (N = 58)	Matched WM (N = 115)	Matched P
Age			.01			.79
Mean	62.7	65.2		62.6	61.9	
Standard Deviation	6.6	7.4		6.7	7.8	
PSA			.01			.11
Mean	10.1	8.7		9.3	8.1	
Standard Deviation	9.4	11.0		6.5	5.9	
PSA density			.32			.55
Mean	0.186	0.179		0.186	0.162	
Standard Deviation	0.157	0.291		0.157	0.141	
DRE			.71			.98
Normal/not done	83.3%	84.8%		84.5%	84.3%	
Abnormal	16.7%	15.2%		15.5%	15.7%	
Family history of PCa			.99			.79
No/unknown	71.7%	71.7%		70.7%	68.7%	
Yes	28.3%	28.3%		29.3%	31.3%	
Biopsy class			.31			.20
Naïve	36.7%	39.4%		36.2%	34.8%	
Previous negative biopsy	36.7%	42.1%		37.9%	49.6%	
Previous positive biopsy	26.7%	18.5%		25.9%	15.7%	

Abbreviations: AAM, African-American men; WM, white men.

clinical variables (eg age and PSA). Furthermore, both AAM and WM had similar rates of higher histologic grade being found on targeted specimens compared to tissue obtained in traditional systematic fashion. These findings suggest that combining mpMRI with other well-established clinical parameters provide equivalent benefit for AAM as for WM.

Concerns regarding overdiagnosis and subsequent overtreatment of PCa have led to an increased emphasis on improving patient selection through risk stratification in the PCa diagnostic pathway. African-American ancestry has long been recognized as an important risk factor for PCa with an incidence nearly 60% higher than men with European-American ancestry. Furthermore, when compared to

Table 2. mpMRI and biopsy characteristics by race

	Unmatched AAM (%)	Unmatched WM (%)	Unmatched P	Matched AAM (%)	Matched WM (%)	Matched P
Highest PIRADS lesion			.97			.86
1	11.7	13.5		10.3	16.5	
2	3.3	3.5		3.4	4.3	
3	18.3	20.7		19.0	18.3	
4	33.3	33.3		32.8	31.3	
5	33.3	29.0		34.5	29.6	
Number of lesions			.91			.44
0	11.7	12.6		10.3	14.8	
1	60.0	61.4		62.1	58.3	
2+	28.3	25.9		27.6	26.9	
MRI lesion location: zone			.27			.43
Peripheral zone	65.0	66.4		65.5	66.1	
Transitional zone	23.3	16.8		24.1	16.5	
Peripheral & transitional lone	0.0	4.3		0.0	2.6	
No lesion	11.7	12.6		10.3	14.8	
MRI lesion location: anterior/posterior			.79			.60
Anterior	20.0	23.5		20.7	23.5	
Posterior	68.3	64.0		69.0	61.7	
No lesion	11.7	12.6		10.3	14.8	
Biopsy gleason			.66			.91
Benign	48.3	46.6		44.8	51.3	
Gleason group 1	18.3	18.5		17.2	13.9	
Gleason group 2	25.0	23.7		25.9	24.3	
Gleason group 3	3.3	5.7		3.4	2.6	
Gleason group 4/5	10.0	5.6		8.6	7.9	

Abbreviations: AAM, African-American men; GGG, Gleason grade group; PIRADS, Prostate Imaging Reporting and Data System; WM, white men.

Table 3. Performance parameters

	Unmatched			Matched		
	AAM (%)	WM (%)	*P*	AAM (%)	WM (%)	*P*
MRI suspicious			.51			.41
PIRADS 1-3	33.3	37.7		32.8	39.1	
PIRADS 4-5	66.7	62.3		67.2	60.9	
High grade biopsy			.60			.68
Benign or GG1	61.7	65.1		62.1	65.2	
GGG 2 +	38.3	34.9		37.9	34.8	
Sensitivity	86.7	83.6	1.00	86.4	80.0	.73
Specificity	45.9	49.1	.71	44.4	49.3	.63
Positive predictive value	50.0	46.9	.71	48.7	45.7	.76
Negative predictive value	85.0	84.8	1.00	84.2	82.2	1.00
Upgrading rate	12.2	15.8	.66	12.2	12.8	.93

Abbreviations: AAM, African-American men; GGG, Gleason grade group; PIRADS, Prostate Imaging Reporting and Data System; WM, white men.

other races, patients of African-American ancestry have a mortality rate double that of any other race category, according to American Cancer Society statistics.[1] Both the American Urological Association[10] and European Association of Urology[11] consider African race to confer increased risk and have specific screening recommendations separate to those for average-risk populations. However, it is clear, additional study is required to better determine optimal screening and management strategies in this population.[12,13]

Genetic differences between races have been suggested to in part explain discrepancies seen in epidemiologic data. Expression and methylation patterns of PCa genes have been shown to vary between AAM and WM.[14,15] However, recognition of this variation has yet to significantly aid in clinical decision-making. Novel biomarker testing has been developed in effort to improve PCa risk stratification including 4Kscore, which uses a panel of 4 kallikrein proteins to assist in calculation of risk for harboring aggressive PCa prior to biopsy. However, initial evidence validating this test included few AAM.[16] Further study has suggested that such a test is likely to provide benefit in American men regardless of race[17] but evidence remains heavily skewed towards a white population. Other biomarker panels have been developed but shown to add predictive value in non-AAM yet do not offer increased value in AAM.[18] It remains unclear to what extent such biomarker testing may aid in decision-making for AAM.

Prostate mpMRI has been shown to be an effective tool in the PCa diagnostic pathway and is suggested to increase detection of clinically significant cancers while limiting discovery of indolent cancers.[4] However, few studies have been done specifically examining mpMRI in AAM as a tool for PCa detection. A recent prospective cohort study demonstrated improved PCa detection with the use of combined MRI-US fusion targeted and systematic core biopsy when compared to systematic biopsy alone, including 195 AAM in their analysis.[17] Other retrospective comparisons have shown compelling findings but have been limited by small sample size. Shin et al included 117 AAM and suggested that targeted MRI-US fusion biopsy detected clinically significant PCa more efficiently than conventional biopsy in AAM and, like our current study, found no significant difference in detection rates in AAM or WM.[19] Walton et al included analysis for 31 AAM and also found similar cancer detection and upgrading rates for AAM and WM when MRI-US fusion biopsy was used. Furthermore, they noted that lesion location did not significantly affect mpMRI performance.[20] The results of the present study add to this growing topic of investigation.

Our study is not without limitations, including its retrospective design, heterogeneous study population, mpMRI inter-reader variability, and a relatively small sample size. However, it does provide supporting evidence that AAM have similar outcomes to WM in PCa detection using mpMRI and might also have similar benefits for PCa detection as seen in larger, prospective trials. To this extent, we suggest that mpMRI should not be withheld or offered preferentially on the basis of race when used for the detection of PCa.

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