ORIGINAL RESEARCH

Cancer Detection Rate of MRI Fusion-targeted and Systematic Prostate Biopsy Based on Urologist-performed MRI Reading and Contouring in a Government Tertiary Hospital

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Introduction: Prostate cancer is a significant health problem worldwide. Transrectal ultrasound guided biopsy has limitations in the detection of clinically significant disease, hence, new imaging including multiparametric MRI and MRI targeted biopsy is developed. In most centers, reading and contouring of the prostate and identification of significant lesions on MRI are performed by radiologists. In this institution, these steps are performed by a urologist.
Objective: To determine the clinically significant cancer detection rate in patients undergoing MRI fusion-targeted and random systematic prostate biopsy where MRI PIRADS scoring, identification of lesions and contouring are performed by a trained urologist in a Philippine tertiary hospital.
Methods: This is a cross-sectional study of patients who underwent MRI fusion prostate biopsy in the Philippine General Hospital (PGH) from June 2021 to June 2023. Clinically significant cancer (csCancer) detection rates were calculated for MRI fusion prostate biopsy, random systematic prostate biopsy, and PIRADS scoring. Concordance was also determined between PIRADS scores and histopathological results.
Results: Forty six (46) patients who underwent MRI fusion biopsy in PGH were included in the study, representing a total of 90 lesions identified by urologists using mpMRA with PIRADS scores of at least 3. Of the patients, 13 (14.4%) were diagnosed with csCancer, while a large proportion was diagnosed with benign prostatic tissue. The csCancer detection rate of MRI fusion biopsy was 28.3% (13/46) and 8.7% (4/46) for random biopsy. The csCancer detection rate was 11.1%, 14.6%, and 36.4% for PIRADS 3, 4, and 5, respectively.
Conclusion: The detection rate of clinically significant prostate cancer using MRI fusion-targeted prostate biopsy based on urologist-performed MRI reading and contouring was superior to random systematic approach. The positive predictive value of PIRADS scores when interpreted by urologists was lower compared to reported values in the literature and did not show concordance. This may reflect lowered thresholds for labeling prostate lesions as suspicious in urologists.

Key words: Prostate cancer, Cancer detection, MRI fusion prostate biopsy, PI-RADS

Introduction

Prostate cancer is a significant health problem worldwide, with an estimated 1.4 million cases and 375,000 deaths in 2020.[1] It is the second most frequent cancer diagnosis made. In the Philippines, prostate cancer is the third most common cancer among men, with an estimated 8,297 new cases and

3,283 deaths in 2020.[2] The incidence of prostate cancer in the Philippines has been increasing in recent years, likely due to the aging population and increased awareness and screening.[3]

Traditionally, the diagnosis of prostate cancer has relied on transrectal ultrasound-guided (TRUS) biopsy. However, TRUS biopsy has limitations in the accurate detection and characterization of prostate cancer, particularly in the detection of clinically significant disease.[4] This has led to the development of new imaging techniques, including multiparametric magnetic resonance imaging (mpMRI) and MRI-targeted biopsy. These have shown promise in the accurate detection and characterization of clinically-significant prostate cancer, defined as Gleason score ≥ 3+4.

MRI fusion prostate biopsy involves a reading and contouring of the prostate and suspicious lesions on MRI images and targeted biopsy of identified lesions. At the Philippine General Hospital, these steps are all performed by a urologist trained in an advanced course in reading of prostate MRI (MRI PRO at the Monash University). Additionally, random systematic sampling of the prostate is also performed to increase the rate of detecting cancer. MRI-targeted biopsy has shown excellent diagnostic performance in detecting clinically significant prostate cancer.[5] However, some studies have revealed that MRI-targeted prostate biopsy can miss the detection of clinically significant prostate cancer in 7-20% of cases that were detected by random systematic sampling.[6,7] However, differences in cancer detection rates between targeted and systematic biopsies in Filipino patients have not been reported.

PIRADS is a standardized system for the interpretation and reporting of prostate mpMRI, which is based on the likelihood of clinically significant prostate cancer.[8] PIRADS V2.1 scores range from 1 to 5, with a score of 1 indicating very low suspicion of clinically significant prostate cancer, while a score of 5 indicates very high suspicion. At the Philippine General Hospital, patients with PIRADS score of at least 3 are advised to undergo prostate biopsy. A meta-analysis of studies reported that the cancer detection rate or positive predictive values of PIRADS 1, 2, 3, 4, and 5 were 6%, 9%, 16%, 59%, and 85%, respectively.[9] In a study done in Filipinos that compared PIRADS scores with transperineal prostate sector biopsy, the cancer detection rate for PIRADS 3, 4, and 5 were 3.3%, 58.7%, and 94.7%, respectively.[10] A recent study in Filipinos showed fair concordance between PIRADS and Gleason scores when mpMRI are read and contoured by a radiologist, with cancer detection rates of 27.3%, 42.4%, 65.3%, and 83.8% for PIRADS 2, 3, 4, and 5, respectively. However, the predictive performance of PIRADS scores read by urologists in detecting clinically significant prostate cancer on MRI fusion-targeted biopsy in Filipinos has not been reported.

Reports of cancer detection rates of diagnostic procedures in Filipino patients with suspected prostate cancer are very few. Moreover, the diagnostic performance of these tests may vary across institutions and readers. Previous studies have demonstrated that contouring inter-reader discrepancies occur among radiologists and between radiologists and urologists.[11,12] There is a need to determine the diagnostic value of MRI fusion targeted biopsy, random systematic biopsy, and PIRADS performed by urologists at the Philippine General Hospital in order to make better clinical decisions from the results and also to prevent subjecting patients to unnecessary procedures which are not without risks.

Methods

This was a cross-sectional study of patients who have undergone MRI fusion prostate biopsy in the Philippine General Hospital from June 2021 to June 2023. This study was conducted among patients who have undergone MRI fusion prostate biopsy in the Philippine General Hospital from June 2021 to June 2023 where the MRI was read and interpreted by and the contouring and identification of lesions for biopsy by an advanced-prostate-MRI-reading-trained urologist (MRI PRO at Monash University),

Inclusion criteria

1. Patients who underwent MRI fusion prostate biopsy in the Philippine General Hospital from June 2021 to June 2023

2. MRI was read and interpreted by an advanced prostate MRI reading-trained urologist, and the contouring and identification of lesions for the targeted biopsy were performed by an advanced prostate MRI reading-trained urologist

Exclusion criteria

1. Cases with significant missing data (>50% of required information missing)
2. MRI was read and interpreted by a radiologist only
3. Contouring and identification of the lesions for the targeted biopsy was performed by a radiologist

The records and operations log of the Division of Urology were reviewed and searched for patients who have undergone MRI fusion prostate biopsy in the Philippine General Hospital from June 2021 to June 2023. Cases were screened and assessed for inclusion in the study based on the preset criteria. The PIRADS scores of the lesions, as interpreted by the trained-urologist, and the Surgical Pathology results were obtained and recorded from the patients' medical records.

The data collected included the following:

- Patient age
- PSA prior to surgery (in ng/mL) - latest level of prostate specific antigen (in ng/mL) taken at the nearest date prior to MRI-fusion prostate biopsy
- PIRADS Score – most recent PIRADS score of each identified lesion from preoperative multiparametric prostate MRI,as identified by a trained urologist
- Location and Zone of Identified Lesions on mpMRI – location and zone of the identified lesions in the multiparametric MRI
- Size and Number of Identified Lesions on mpMRI – greatest diameter of each of lesions identified and the number in the multiparametric prostate MRI results
- Prostate Size on mpMRI- prostate size determined on preoperative mpMRI as measured by the trained urologist
- Gleason Score – Gleason grading system score (expressed as Grade Group per International Society of Urologic Pathology) for each lesion
- Complete histopathological report - histopathological report for each prostate biopsy core sample, including presence of prostate cancer, cancer histology, Gleason score and other pathological findings (e.g., inflammation, hypertrophy, atrophy)

Continuous variables (age, size of lesion and prostate, PSA) were expressed as mean and standard deviation and categorical variables (location and zone of lesion, Gleason score, other histopathological findings) were expressed as counts and frequencies. The total number of clinically significant prostate cancer cases were the number of patients with Gleason score $\geq$ 3+4 upon either MRI fusion-targeted or random systematic prostate biopsy. Clinically significant cancer (csCancer) detection rate was calculated as follows:

$$\text{csCancer detection rate (targeted)} = \frac{\text{No. of patients w/ clinically significant prostate cancer (targeted)}}{\text{Total no. of patients biopsied}}$$

$$\text{csCancer detection rate (random systematic)} = \frac{\text{No. of patients w/ clinically significant prostate cancer (systematic)}}{\text{Total no. of patients biopsied}}$$

The performance of PIRADS read by urologists in predicting clinically significant prostate cancer was evaluated by comparing the most recent PIRADS score of each identified lesion on mpMRI to the histopathology result. The corresponding positive predictive value for PIRADS scores 3, 4, and 5 were calculated as:

$$\text{csCancer detection rate (PIRADS score)} = \frac{\text{No. of clinically significant prostate cancer lesions for a PIRADS score}}{\text{Total no. of lesions for a PIRADS score}}$$

This can also be referred to as the positive predictive value of each PIRADS score.

Kendall's τ_B (tau-b) was determined to evaluate whether there was congruence between PIRADS scores and Gleason scores because these outcomes were ordinal variables. For tests that showed statistical significance (p-value < 0.05), the relationship between PIRADS and Gleason scores was interpreted as insignificant, fair, moderate, good, and strong for Kendall's τ_B 0–0.20, 0.21–0.40, 0.41–0.60, 0.61–0.80, and 0.80–1, respectively.

The study protocol was approved by the University of the Philippines Research Ethics Board (UPM-REB) and was implemented in accordance to the principles of Good Clinical Practice and the Declaration of Helsinki.

Results

Between June 2021 to June 2023, forty six (46) patients underwent MRI fusion prostate biopsy in the Philippine General Hospital where MRI reading and contouring was performed by urologists. Their clinical, imaging, and pathological profiles are summarized in Table 1. The mean age of patients was 66.5 years, with median pre-biopsy PSA of 12.63 ng/mL and median prostate size of 43 grams. A total of 90 lesions were identified using mpMRI, with median lesion size of 11 mm. Patients were fairly distributed across PIRADS scores 3, 4, and 5 when considering the highest PIRADS score. At a lesion-level, more lesions were classified as PIRADS 4. Lesions were more frequently located in the midgland or apex and in the transition zone.

Of the lesions identified, 21 were histopathologically diagnosed as prostate cancer, with 4 lesions classified with Gleason score of 6 (3+3) and 17 lesions with a Gleason score of at least 7 (3+4). Thus, there were 13 patients diagnosed with csCancer (14.4%) and 2 non-csCancer. A majority of patients were histopathologically diagnosed with benign prostatic tissue.

The csCancer detection rate of MRI fusion-targeted prostate biopsy was 28.3% (13/46), while for random systematic prostate biopsy, the rate was 8.7% (4/46). It should be noted that all patients that were found to have csCancer were detected by MRI fusion-targeted prostate biopsy.

Comparison of urologist-interpreted PIRADS scores with MRI fusion prostate biopsy results

Table 1. Clinical, imaging, and pathological profile of patients who underwent MRI fusion prostate biopsy in the Philippine General Hospital from June 2021 to June 2023.

Parameter	Total (%)
Number of patients	46
Mean age in years (SD)	66.5 (10.2)
Median pre-biopsy PSA in ng/mL (range)	12.63 (4.2-185)
Median prostate size in grams (range)	43 (16-120.4)
Number of prostate lesions	90
Median lesion size in mm (range)	11 (2.6-36)
Patient-level PIRADS score (highest PIRADS)	
3	15 (32.6)
4	14 (30.4)
5	17 (37.0)
Lesion-level PIRADS score (highest PIRADS)	
3	27 (30.0)
4	41 (45.6)
5	22 (24.4)
Location of lesion	
Base	20 (22.2)
Midgland	30 (33.3)
Apex	31 (34.4)
Base to Midgland	2 (2.2)
Midglant to Apex	4 (4.4)
Base to Apex	3 (3.3)
Zone of lesion	
Central	5 (5.6)
Transition	44 (48.9)
Peripheral	37 (41.1)
Transition and Peripheral	4 (4.4)
Gleason scores of targeted lesions	
3+3=6	4
3+4=7	8
4+3=7	4
4+4=8	3
4+5=9	0
5+4=9	2
Diagnosis	
Clinically-significant prostate cancer	13 (14.4)
Non-clinically-significant prostate cancer	2 (2.2)
Atypical small acinar proliferation	1 (1.1)
Benign prostatic tissue	26 (28.9)
Benign prostatic tissue with chronic prostatitis	2 (2.2)
Prostatitis	2 (2.2)

Table 2. Comparison of urologist-interpreted PIRADS scores with MRI fusion prostate biopsy results.

PIRADS Score	Clinically significant prostate cancer on MRI fusion prostate biopsy pathology results			csCancer detection rate (PIRADS score)
	Positive	Negative	Total	
PIRADS 3	3	24	27	11.1%
PIRADS 4	6	35	41	14.6%
PIRADS 5	8	14	22	36.4%

are shown in Table 2. The csCancer detection rate (or positive predictive value) was 11.1%, 14.6%, and 36.4% for PIRADS 3, 4, and 5, respectively. Concordance between these measures was nominally fair, based on Kendall's τ_B of 0.221. However, this was not statistically significant (p=.16108).

Discussion

Detection of clinically significant disease is an important step in the diagnosis of prostate cancer. In addition to TRUS biopsy, PIRADS using mpMRI, MRI fusion targeted biopsy, and systematic random biopsy are options for diagnosing prostate cancer. While MRI modalities are typically performed by radiologists, urologists contour and interpret prostate MRI images in some centers, such as the Philippine General Hospital.

In the current study, MRI fusion-targeted prostate biopsy was able to detect all csCancer cases, showing better diagnostic performance than systematic biopsies. However, among targeted biopsies performed, only 28.3% were truly clinically significant. Moreover, the positive predictive values of PIRADS scores were lower compared to previous reports in the Filipino population.[13] These data suggest possible false positives in the labeling of prostate lesions as suspicious and assigning PIRADS scores when performed by urologists. This could reflect lower thresholds for targeted biopsies in urologists. More clinical experience and close follow-up of patients may be helpful in providing feedback to urologists who perform contouring and interpretation of prostate MRI.

Previous work showed mismatch between segmentations performed by urologists and radiologists.[12] Agreement between readings was positively correlated with lesion size, suggesting that this variable could be an important factor to consider when performing targeted biopsy. However, agreement among radiologists was also moderate, indicating challenges in performing these diagnostic procedures.

This study has several limitations, notably the small sample size and lack of comparison with radiologist readings. Future studies may include more patients as the institution gains more experience with performing targeted biopsies.

Conclusion

The detection rate of clinically-significant prostate cancer using MRI fusion-targeted prostate biopsy based on urologist-performed MRI reading and contouring was 28.3%, which was superior to random systematic approach. The positive predictive value when interpreted by urologists was 11.1%, 14.6%, and 36.4% for PIRADS 3, 4, and 5, respectively, but did not show concordance. This may reflect lowered thresholds for identifying prostate lesions as suspicious in urologists.

References

1. Bray F, Colombet M, Mery L, Piñeros M, Znaor A & Zanetti R. Cancer Incidence in Five Continents, vol. XI (electronic version). Lyon: International Agency for Research on Cancer. [Internet] 2021 [cited 2024 January 14] Available from https://ci5.iarc.fr
2. Ferlay J, Colombet M, Soerjomataram I, Parkin DM, Piñeros M, Znaor A, et al. Estimating the global cancer incidence and mortality in 2020: GLOBOCAN sources and methods. Int J Cancer 2021 Apr 22;149(4):778–96. DOI:10.1002/ijc.33588
3. Dy JG, Pascual JLP & Lantion-Ang FL. Philippine Cancer Facts and Estimates. Philippine Cancer Society. [Internet] 2017 [cited 2024 January 14] Available from https://philcancer.org.ph/wp-content/uploads/2018/08/2017-Philippine-Cancer-Facts-and-Estimates.pdf.
4. Moldovan PP, Van den Broeck T, Sylvester, et al. What is the most accurate diagnostic modality for prostate cancer? A systematic review and network meta-analysis of more than 10,000 Men. Eur Urol 2020; 79(3): 328-39. 2021. DOI: 10.1016/j.eururo.2020.10.045

5. Kasivisvanathan V, Rannikko AS, Borghi M, Panebianco V, Mynderse LA, Vaarala MH, et al. MRI-targeted or standard biopsy for prostate-cancer diagnosis. New Engl J Med 2018 May 10;378(19):1767–77. DOI:10.1056/nejmoa1801993
6. Filson CP, Natarajan S, Margolis DJA, Huang J, Lieu P, Dorey FJ, et al. Prostate cancer detection with magnetic resonance-ultrasound fusion biopsy: The role of systematic and targeted biopsies. Cancer. 2016 Jan 7;122(6):884–92. DOI:10.1002/cncr.29874
7. Elkhoury FF, Felker ER, Kwan L, Sisk AE, Delfin M, Natarajan S, et al. Comparison of targeted vs systematic prostate biopsy in men who are biopsy naive. JAMA Surg 2019 Sept 1;154(9):811–8. DOI:10.1001/jamasurg.2019.1734
8. O'Shea A, Harisinghani M. Pi-rads: Multiparametric MRI in prostate cancer. Magnetic Resonance Materials in Physics, Biology and Medicine. 2022 May 21;35(4):523–32. DOI:10.1007/s10334-022-01019-1
9. Oerther B, Engel H, Bamberg F, Sigle A, Gratzke C, Benndorf M. Cancer detection rates of the PI-RADSv2.1 assessment categories: Systematic review and meta-analysis on lesion level and patient level. Prostate Cancer and Prostatic Diseases 2021 Jul 6;25(2):256–63. DOI:10.1038/s41391-021-00417-1
10. Alpajaro SI, Letran J. Multi-Parametric Magnetic Resonance Imaging (MpMRI) Based Prostate Imaging and Reporting Archiving Data System (PIRADS): Utility in improving cancer detection, localization and characterization. Philip J Urol [Internet]. 2020Feb.16 [cited 2024 Jan 14];26(1):24-31. Available from: https://pjuonline.com/index.php/pju/article/view/19
11. Liechti MR, Muehlematter UJ, Schneider AF, Eberli D, Rupp NJ, Hötker AM, et al. Manual prostate cancer segmentation in MRI: Interreader agreement and volumetric correlation with transperineal template core needle biopsy. Eur Radiol 2020 Apr 19;30(9):4806–15. DOI:10.1007/s00330-020-06786-w
12. Ghafoor S, Steinebrunner F, Stocker D, Hötker AM, Schmid FA, Eberli D, et al. Index lesion contouring on prostate MRI for targeted MRI/US fusion biopsy – evaluation of mismatch between radiologists and urologists. Eur J Radiol 2023 May;162:110763. doi:10.1016/j.ejrad.2023.110763
13. Loo LG, Serrano DP, Lusaya DG, Pile FC, Mendoza JS. Concordance of Multiparameteric MRI and MRI ultrasound fusion-guided prostate biopsy. PJU [Internet]. 2022Jan.25 [cited 2024 Jan 14];31(1). Available from: https://pjuonline.com/index.php/pju/article/view/124