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MRI-guided biopsy reduces biochemical recurrence in prostate cancer patients undergoing radiation therapy: a single-center study from Thailand

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Accurate diagnosis of significant prostate cancer (PCa) is essential for effective treatment. Multiparametric magnetic resonance imaging (mpMRI) is increasingly used for lesion detection and biopsy guidance, but its impact on outcomes following radiotherapy remains uncertain. This study assesses the effect of MRI-guided biopsy on biochemical recurrence (BCR) following definitive external beam radiotherapy (EBRT). This single-center, retrospective review included 102 patients with localized PCa who received primary EBRT between 2018 and 2021. The MRI-guided biopsy group underwent both targeted and systematic biopsies, while the non-MRI-guided biopsy group underwent systematic biopsy alone. All patients underwent pre-treatment MRI (pre-RT MRI). Kaplan-Meier analysis compared BCR-free survival between the MRI-guided and non-MRI-guided biopsy groups. Among the 102 patients, 57 underwent MRI-guided biopsy, with 52.9% classified as intermediate-risk. The median follow-up period was 57.2 months. The proportion of very-high-risk patients was significantly greater in the non-MRI-guided biopsy group (24.4% vs. 3.5%, $p = 0.01$). Seventeen patients in the non-guided biopsy group were staged as T3 with the assistance of the pre-RT MRI. Despite the use of pre-RT MRI in all non-MRI-guided biopsy cases, four patients experienced BCR, whereas no BCR was observed in the MRI-guided biopsy group. The MRI-guided biopsy group demonstrated superior BCR-free survival ($p < 0.01$) across both intermediate- and higher-risk groups. MRI-guided biopsy was associated with a reduced risk of BCR following definitive EBRT, particularly in intermediate-risk patients. In contrast, systematic random biopsies, even when combined with pre-RT MRI, were linked to poorer intermediate oncologic outcomes.

Keywords Magnetic resonance imaging, MRI-guided biopsy, Prostate cancer, External beam radiotherapy, Biochemical recurrence, Oncologic outcomes

Accurate diagnosis of clinically significant prostate cancer (PCa) is crucial for ensuring effective treatment and improving patient outcomes. In recent years, multiparametric magnetic resonance imaging (mpMRI) has emerged as an essential tool for detecting lesions and guiding biopsies, enhancing the precision of PCa diagnosis. Multiple studies have demonstrated that the incorporation of MRI-targeted biopsies improves the detection rate of clinically significant PCa (csPCa)[1–4], while reducing the unnecessary biopsies for indolent cancers[5–7]. MRI-guided biopsies, when combined with traditional systematic biopsy, enable more accurate risk stratification, potentially facilitating individualized treatment planning. MRI-guided biopsies have been shown to reclassify risk in approximately 38% of cases, which can significantly alter treatment decisions[8–10].

Both radical prostatectomy (RP) and radiotherapy (RT) are well-established treatment options for localized PCa. While studies have suggested that pre-treatment MRI can reduce the rates of positive surgical margins in patients undergoing RP[11,12], limited evidence exists regarding the impact of MRI-guided biopsies on outcomes

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following external beam radiotherapy (EBRT), particularly in terms of biochemical recurrence (BCR) following treatment.

This study aims to evaluate whether MRI-guided targeted biopsy reduces BCR rates compared to systematic biopsy alone in patients undergoing definitive EBRT for localized PCa. We hypothesize that MRI-guided biopsies improve patient outcomes by providing better risk stratification, thereby allowing for more tailored treatment strategies. Patients with prostate-specific agent (PSA) levels ≥ 20 ng/mL were intentionally excluded, as EBRT protocol and androgen deprivation therapy (ADT) duration in these cases are not dependent on tissue findings.

Materials and methods

Data collection

This retrospective, single-center study was approved by the Siriraj Institutional Review Board (SIRB). In line with the institution's research protocol, informed consent was managed to allow patients the option to opt-out. The research was carried out in full compliance with the Declaration of Helsinki and all relevant regulations set forth by the SIRB.

Data were collected from patients newly diagnosed with localized adenocarcinoma of the prostate, with PSA levels below 20 ng/mL, who received definitive EBRT between January 2018 and December 2021. Patients with incomplete data, PSA levels ≥ 20 ng/mL, or those who had undergone previous local treatments, pelvic radiation, or palliative RT were excluded.

Patient characteristics recorded included age, initial PSA levels, Gleason score (GS), biopsy technique, percentage of positive biopsy cores, clinical T-stage assessed with mpMRI, risk classification based on the NCCN Guidelines Version 4.2021, EBRT technique, use of ADT, radiographic and/or MRI findings, and follow-up duration. For patients who developed BCR, additional details such as time to BCR, failure patterns, and treatments following BCR were reviewed.

Local failure is defined as residual or recurrent disease confined to the prostate. Regional failure refers to metastasis to regional lymph nodes, specifically the pelvic lymph nodes located below the bifurcation of the common iliac arteries. Distant metastatic failure is defined as metastasis to non-regional lymph nodes, bone, or other visceral organs.

Biopsy groups

Patients were divided into two groups: an MRI-guided biopsy group and a non-MRI-guided group. The MRI-guided group underwent mpMRI within six months before biopsy, receiving both MRI-targeted biopsy, either via MRI-transrectal ultrasound (TRUS) fusion-targeted biopsy or MRI-guided in-bore biopsy, along with systematic biopsies. The non-MRI-guided group, which did not undergo mpMRI before biopsy, received transrectal systematic biopsies, with five to six cores taken from each lobe.

For patients whose biopsies were performed at external institutions, pathology slides were reviewed by in-house genitourinary pathologists to ensure consistent evaluation. Transurethral resection of the prostate (TURP) specimens were included when applicable, primarily due to clinical benign prostatic hyperplasia with a normal preoperative digital rectal exam.

Metastasis workup

To assess distant metastasis, most patients underwent bone scintigraphy, while selected patients received Positron Emission Tomography/Computed Tomography (PET/CT) scans with Fluorine-18 or Gallium-68 prostate-specific membrane antigen (PSMA) for more detailed imaging. These diagnostic tools confirmed the absence of metastatic disease prior to initiating RT.

Treatment decisions based on biopsy results

Treatment plans were determined based on biopsy results in both groups. For patients with high-risk features (e.g., GS ≥ 8, a higher percentage of positive cores, or extracapsular extension), dose-escalated EBRT and long-term ADT were applied. These adjustments were made based on biopsy and MRI results to optimize treatment for each risk category.

Treatment protocols for patients in the higher-risk group, including those classified as high- and very high-risk, were similar. At the time of this study, no androgen receptor pathway inhibitors (ARPIs) were administered.

Imaging and radiation protocol

All patients underwent MRI simulations of the prostate as part of the EBRT planning. The MRI included T2-weighted (T2W) and diffusion-weighted imaging (DWI)/apparent diffusion coefficient (ADC) sequences, along with CT simulation. Treatment was based on MRI findings, clinical staging, PSA levels, and GS (Fig. 1).

EBRT was delivered to cover the prostate gland, proximal seminal vesicles, and, in high-risk patients, the distal seminal vesicles and pelvic lymph nodes. Treatment modalities included conventional fractionation (78 Gy in 39 fractions), moderate hypofractionation (70–72.8 Gy in 28 fractions), or stereotactic body radiotherapy (SBRT) (36.25 Gy in 5 fractions) using intensity-modulated radiotherapy (IMRT). A simultaneous integrated boost (SIB) to the dominant intraprostatic lesion (DIL) was administered in selected unfavorable-risk patients.

Outcome and statistical analysis

The primary outcome was biochemical recurrence-free survival (bRFS), defined as the time from the completion of EBRT to BCR, in accordance with the Phoenix definition (PSA rise ≥ 2 ng/mL from nadir). Long-term ADT was defined as treatment extending beyond 18 months, while short-term ADT was defined as treatment lasting 18 months or less.

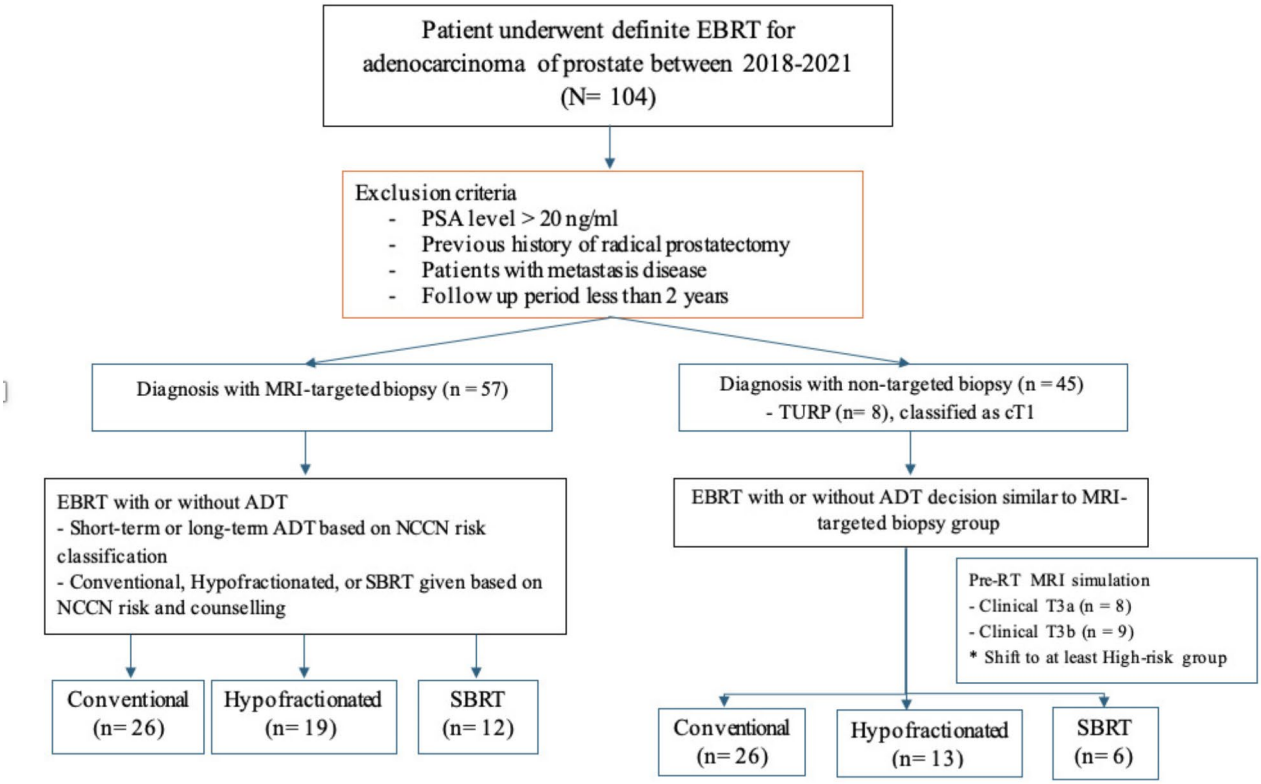


Fig. 1. Study design and treatment flow for EBRT in prostate cancer.

Statistical analyses, including Kaplan-Meier (KM) estimates for bRFS, were performed using Stata/MP version 16.1 (StataCorp. 2020, College Station, TX, USA). Numerical data with non-normal distributions were presented as medians and ranges, while categorical data were depicted as counts and percentages. A p-value < 0.05 was considered statistically significant.

Results

Between January 2018 and December 2021, a total of 102 patients with localized PCa were included in this study. Of these, 57 patients underwent MRI-guided biopsy, while 45 received non-MRI-guided systematic biopsy. The baseline characteristics of both groups are presented in Table 1. The majority of patients in both groups were classified as intermediate-risk (52.9%) or high-risk (26.5%), based on the NCCN guidelines.

Patient and tumor characteristics

The median age of all patients was 76.5 years (range: 51–88), with no statistically significant difference between the MRI-guided and non-MRI-guided groups (77 vs. 74 years; $p = 0.66$). The median iPSA level was 8.9 ng/mL (range: 2.2–19.6), with no significant difference between the groups ($p = 0.38$).

A significantly higher proportion of patients in the non-MRI-guided group had GS 6 (24.4% vs. 8.9%) and GS 8–10 (31.1% vs. 21.4%; $p = 0.03$). Thirty patients (29.4%) had clinical T3 disease, as identified by MRI.

In the MRI-guided group, the majority were intermediate risk (57.9%), whereas the non-MRI-guided group had a higher proportion of very-high-risk patients (24.4% vs. 3.5%; $p = 0.01$). The median percentage of positive biopsy cores was similar between the groups ($p = 0.35$).

Radiation therapy and androgen deprivation therapy

All patients received EBRT, with treatment regimens including conventional fractionation (51.0%), moderate hypofractionation (31.4%), or SBRT (17.7%). There was no significant difference in the distribution of EBRT modalities between the two groups ($p = 0.42$). Additionally, 82 patients received ADT, with long-term ADT administered to 53.7% of patients. A slightly higher, though statistically insignificant, proportion of patients in the non-MRI-guided group received long-term ADT (60% vs. 48.9%). The median duration of ADT was 23 months, with 6.1 months in the short-term ADT group and 24.8 months in the long-term ADT group. No significant difference was observed in the duration of ADT between the two groups ($p = 0.42$). The median follow-up time was 57.2 months (range: 21.8–83.1), with no significant difference between the groups ($p = 0.67$).

Characteristics of patients in MRI-guided biopsy group

Table 2 outlines the MRI findings and biopsy results of patients in the MRI-guided biopsy group. Among the 54 patients, 34 patients had PIRADS 4 lesions at the time of biopsy. Thirteen patients were identified as having

Characteristics	Total (*N* = 102)	MRI-guided biopsy (*N* = 57)	Non-MRI-guided biopsy (*N* = 45)	*p*-value
Age (yr)	76.5 (51–88)	77 (53–87)	74 (51–88)	0.66
iPSA (ng/mL)	8.9 (2.2–19.6)	8.4 (3.2–19.6)	10.4 (2.2–16.2)	0.38
Gleason score [a]				0.03
6 (3 + 3)	16 (15.8)	5 (8.9)	11 (24.4)	
7 (3 + 4, 4 + 3)	59 (58.4)	39 (69.6)	20 (44.4)	
8–10 (4 + 4, 4 + 5, 5 + 4, 5 + 5)	26 (25.7)	12 (21.4)	14 (31.1)	
Percentage of positive cores [b]	33.3 (4.5–100)	34.3 (4.5–100)	26.8 (7.1–100)	0.35
T staging				0.26
T1c-2	72 (70.6)	44 (77.2)	28 (62.2)	
T3	30 (29.4)	13 (22.8)	17 (37.8)	
Risk group				0.01
Low	8 (7.8)	6 (10.5)	2 (4.4)	
Intermediate	54 (52.9)	33 (57.9)	21 (46.7)	
High	27 (26.5)	16 (28.1)	11 (24.4)	
Very high	13 (12.7)	2 (3.5)	11 (24.4)	
Radiotherapy				0.42
Stereotactic body radiotherapy	18 (17.7)	12 (21.1)	6 (13.3)	
Moderate hypofractionation	32 (31.4)	19 (33.3)	13 (28.9)	
Conventional fractionation	52 (51.0)	26 (45.6)	26 (57.8)	
Androgen deprivation therapy	82 (80.4)	47 (82.5)	35 (77.8)	0.32
Short term	38 (46.3)	24 (51.1)	14 (40)	
Long term	44 (53.7)	23 (48.9)	21 (60)	
Androgen deprivation therapy duration (mo)	23 (3–45.8)	11.3 (3–45.8)	23.7 (5.7–37.6)	0.42
Short term	6.1 (3–18)	6.1 (3–11.3)	6.2 (5.7–18)	
Long term	24.8 (19.8–45.8)	24.8 (22.9–45.8)	24.8 (19.8–37.6)	
Follow-up time (mo)	57.2 (21.8, 83.1)	57 (21.8, 82.8)	58.9 (23.5, 83.1)	0.67

Table 1. Patient, tumor and treatment characteristics. Data was reported as median (range), or number (%) [a]Gleason score was unavailable in 1 patient of the MRI-guided biopsy due to a limited amount of specimen to confidently render a grade. [b]Data were available in 86 patients: 54 patients in the MRI-guided biopsy, and 32 patients in the non-MRI-guided biopsy

Characteristics	*N* = 54
PIRADS 3	1
PIRADS 4	34
PIRADS 5	19
Extraprostatic extension	9
Seminal vesical invasion	4
Negative random biopsy	5
• Gleason grade group 3	3
• Gleason grade group 4	1
• Gleason grade group 5	1
Negative targeted biopsy	3
• Gleason grade group 3	0
• Gleason grade group 4	1
• Gleason grade group 5	2
Cases with multiple suspicious lesions on MRI	24

Table 2. Characteristics of patients in the MRI-Guided biopsy group.

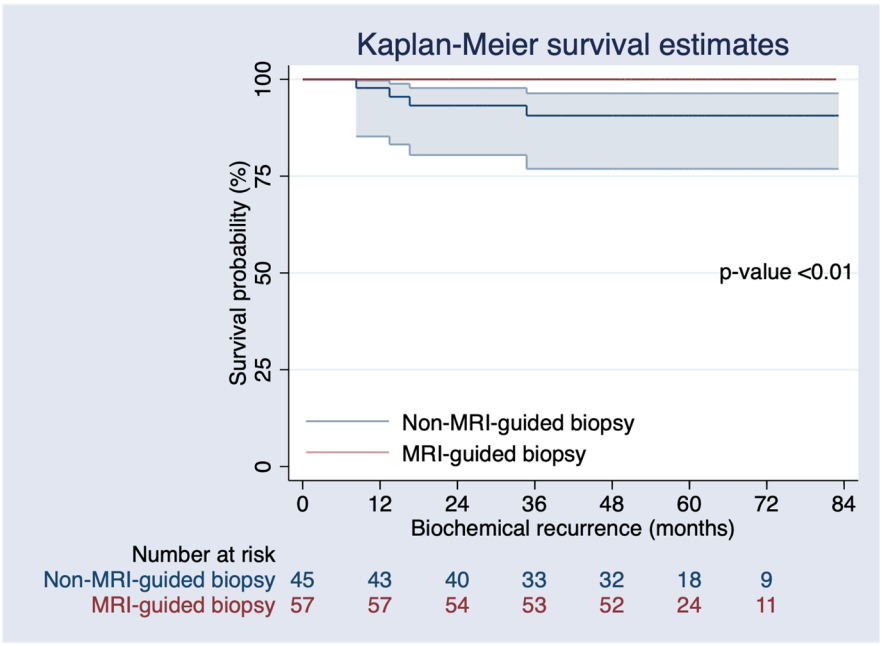
T3 disease on MRI at the time of biopsy. The ultimate benefits of MRI-targeted biopsy was observed in five patients, where systematic biopsy results were negative, yet MRI-targeted biopsy detected clinically significant PCa. Conversely, four patients were diagnosed with PCa via systematic biopsy alone, despite MRI indicating significant lesions. Additionally, MRI detected multiple suspicious lesions in 24 cases.

Biochemical recurrence and Kaplan–Meier analysis

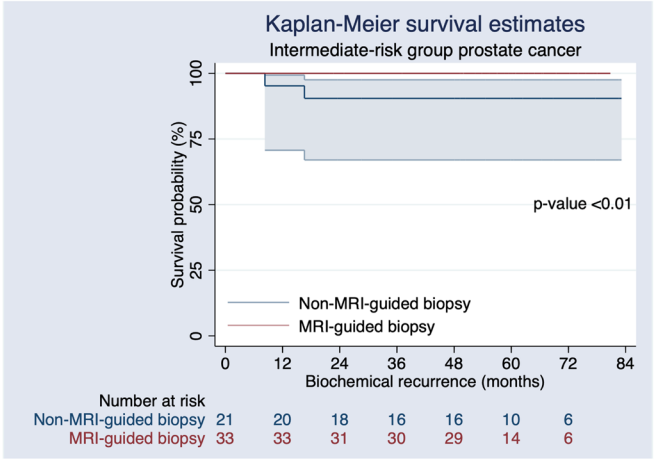
At a median follow-up of 57.2 months, four patients (9%) in the non-MRI-guided group experienced BCR, while no patients in the MRI-guided group developed BCR (Fig. 2). Due to the higher proportion of aggressive disease in the non-MRI-guided group (including a higher GS and more very high-risk patients), a stratified KM analysis was conducted.

Among intermediate-risk patients, as shown in Fig. 2b, the 4-year bRFS was significantly higher in the MRI-guided group compared to the non-MRI-guided group with no patient experiencing BCR (100% vs. 94.5%, $p < 0.01$), with no BCR events occurring in the MRI-guided group. Similarly, as demonstrated in Fig. 2c, the MRI-guided group maintained superior 4-year bRFS within the higher-risk category, which included both high- and very high-risk patients.

To further assess the potential benefits of MRI-guided biopsy, a sensitivity analysis was conducted to account for the slightly higher proportion of very high-risk patients in the non-MRI-guided group. First, low-risk patients were excluded to focus on individuals at a clinically meaningful risk of BCR (Fig. 3a). Next, high-risk and very high-risk patients were excluded, allowing for an evaluation of whether MRI-targeted biopsy benefits remained evident in lower-risk individuals (Fig. 3b). As a result, when excluding low-risk patients, MRI-guided biopsy remained significantly associated with improved bRFS ($p = 0.03$). However, when, high- and very high-



A



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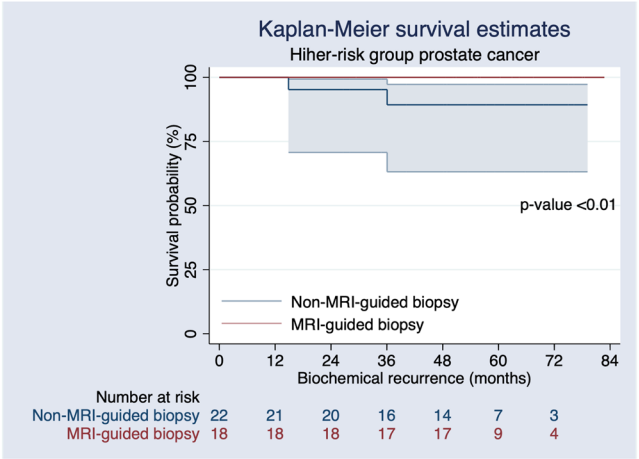

C

Fig. 2. The Kaplan–Meier graph of the biochemical recurrence free survival in overall patients with localized prostate cancer underwent primary radiation therapy (**A**), the Kaplan–Meier graph comparing biochemical recurrence free survival between patients in intermediate-risk group (**B**) and higher-risk group (consisting of high and very-high risk groups) (**C**).

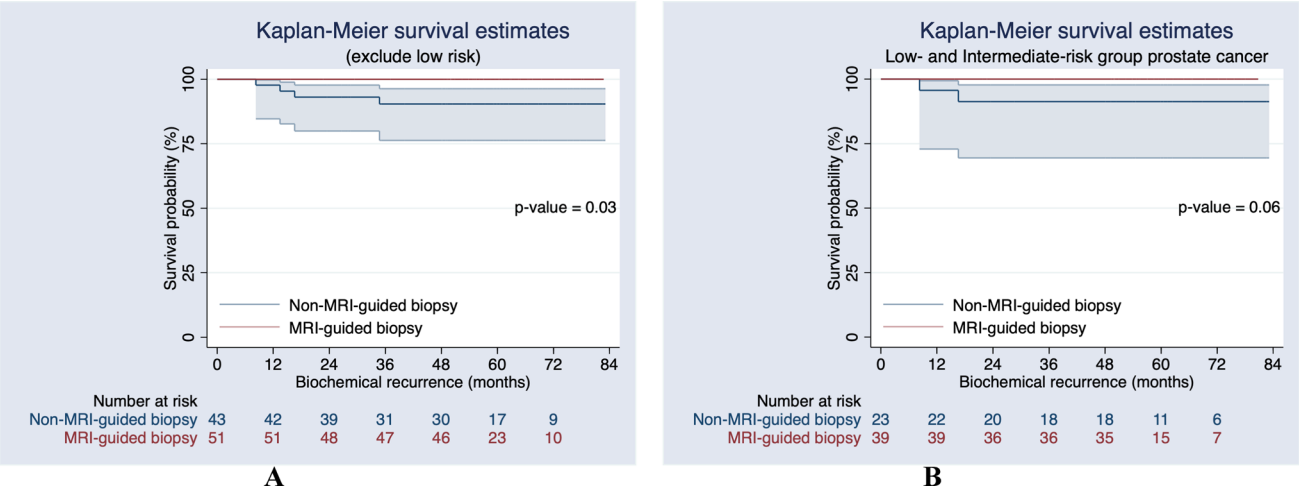

Fig. 3. The Kaplan–Meier graph comparing biochemical recurrence free survival between patients in non-low-risk group (**A**) and low-/intermediate-risk group (**B**).

Case	Age	iPSA (ng/mL)	GS	cT stage	Prostate Volume (mL)	Risk group	Radiation	ADT	Time to BCR (mo)	Pattern of failure	Imaging modality	Treatment
1	65	12.8	3 + 3	T1c	76.7	Unfavorable IR	60 Gy/20 F	LT	16.6	PSA failure	Bone scan, MRI	ADT
2	71	10.3	3 + 3	T1c	47.0	Favorable IR	72.8 Gy/28 F	-	8.3	Local failure	PET/CT PSMA	ADT
3	84	4.1	5 + 4	T3b	16.2	Very HR	72.8 Gy/28 F	LT	13.5	Local and distant failure	Bone scan, MRI	ADT
4	82	3.7	5 + 4	T3a	16.5	Very HR	72.8 Gy/28 F	LT	34.7	Local and regional failure	Bone scan, PSMA PET/CT	MDT and ADT

Table 3. Characteristics of patients who developed biochemical recurrence and subsequent treatments. iPSA, initial prostate specific antigen; GS, Gleason score; cT, clinical T stage; IR, intermediate risk; F, fraction; ADT, androgen deprivation therapy; LT, long-term; BCR, biochemical recurrence; RT, radiotherapy; N/A, not available; MDT metastasis-directed therapy. Intermediate-risk patients were stratified into favorable and unfavorable subgroups based on NCCN guidelines, using the percentage of positive biopsy cores as a criterion (< 50% for favorable vs. ≥50% for unfavorable). Repeated biopsies at the time of BCR were not conducted because local salvage treatments, such as salvage prostatectomy, high-intensity focused ultrasound (HIFU), or cryotherapy, were not routinely accessible. Instead, PET/CT PSMA was preferred for evaluating BCR but was not consistently performed due to reimbursement policy limitations.

risk patients were excluded, the bRFS difference became statistically weaker ($p = 0.06$). These findings reinforce the importance of MRI-guided-biopsy in identifying aggressive disease, ultimately leading to improved long-term outcomes in intermediate- and higher-risk disease.

Patterns of recurrence

All four patients who developed BCR were from the non-MRI-guided group, with two of them classified as low-risk. Abnormal intraprostatic lesions were detected by pre-RT MRI in both cases, despite an initial GS 3 + 3. However, because these lesion were not detectable by digital rectal examination, they were classified as T1c.

Among the very high-risk patients, one experienced both local recurrence and distant metastasis, while the other had local recurrence and regional metastasis. Notably, no patients in the intermediate-risk group developed distant metastases. Table 3 outlines the characteristics, treatments, and failure patterns of the patients who developed BCR.

Prostate biopsy was not performed in BCR cases, as local salvage treatments were not available at our institution during the study period. PSMA PET/CT scans were conducted in two cases, one of which was used to guide metastasis-directed RT.

Discussion

The findings of this study suggest that MRI-guided biopsy significantly improves bRFS in patients with localized PCa treated with EBRT. None of the patients in the MRI-guided group experienced BCR during the median follow-up period of 57.2 months, compared to 9% in the non-MRI-guided group. These results emphasize the

benefits of MRI-targeted biopsies in enhancing risk stratification and facilitating more tailored and effective treatment strategies[9,10].

MRI has become a recognized tool for improving PCa detection and risk classification. *Klotz et al.*[2]. reported a 50% reduction in progression and failure rates in patients undergoing MRI-guided biopsy while on active surveillance, highlighting the benefits of precise tumor characterization. Similarly, *Jäderling et al.*[12]. demonstrated that preoperative MRI reduced positive surgical margins rate in patients undergoing RP, underscoring its role in optimizing treatment outcomes. Consistent with these findings, our results demonstrate that MRI-guided biopsy not only enhances risk assessment but also improves treatment outcomes by reducing recurrence rates in EBRT patients.

Currently, MRI-directed biopsy and treatment becoming a standard of care for patients experience elevated serum PSA. However, data regarding the benefits of incorporating this approach for patients treated with EBRT remain limited. To fully demonstrate the benefits of MRI-targeted biopsy on PCa treatment outcomes, an improvement in bRFS or a reduction in BCR over the systematic biopsy alone would be expected across all risk groups, particularly among low- and intermediate-risk patients, where misclassification can lead to variations in EBRT protocols or ADT duration. Notably, none of the low-risk patients in this study experienced BCR after 57 months of follow-up when pre-RT MRI was utilized. A recent meta-analysis of 2,205 patients assessing the impact of pre-treatment MRI findings in patient treated with RT identified extraprostatic extension, seminal vesicle invasion, large tumor size, and tumor involvement at the apex as significant predictors of BCR following RT[13]. Additionally, Chatterjee et al. demonstrated the predictive value of ADC measurement, showing that no failures occurred in patients with an ADC value of the index lesion ≥ 0.96 $\mu m^2/ms$[14]. Although a longer follow-up is required to fully clarify the benefit of MRI-guided-biopsy beyond pre-treatment MRI alone, these findings may prompt reconsideration of the necessity for extensive pre-treatment evaluation, including MRI and more costly targeted biopsy, particularly in low-risk patients in resource-limited settings, where financial or MRI access constraints exist.

While the stratified KM analysis provided insights into the benefits of MRI-guided biopsy on BCR following EBRT, caution is warranted when interpreting its advantages in high-and very high-risk patients. The higher recurrence rates observed in the non-MRI-guided group can be attributed to a greater proportion of patients with GS 8–10 and a higher percentage of very-high-risk cases. Attard et al. demonstrated superior 6-year metastasis-free survival when 1,000 mg of abiraterone acetate was administered in combination with 74 Gy in 37 fractions of EBRT (equivalent hypofractionated schedules) to patients with high-risk features (T3/T4 stage, GS 8–10, PSA ≥ 40 ng/mL, or node-positive disease). In that study, 31% of patients experienced metastasis when abiraterone or enzalutamide was not given (vs. 18%), and bRFS was 86 months in the non-ARPI group (vs. not reached in the ARPI group)[15]. Since none of our patients received the abiraterone or ARPI therapy, further investigations are needed to determine whether MRI-guided biopsy offers distinct advantages over systematic biopsy alone in this higher-risk population. Nevertheless, it's noteworthy that 17 patients in the systematic biopsy group of our study were found to have extraprostatic extension or seminal vesical invasion (clinical T3) by the assistance of pre-RT MRI.

A particularly significant finding of this study is that notable improvement in bRFS among intermediate-risk patients who underwent MRI-guided biopsy, even though pre-RT MRI was routinely performed. This improvement is likely attributed to the more precise tumor staging and risk classification facilitated by MRI-targeted biopsy, which has been shown to upstage approximately 38% of patients compared to systematic biopsies alone, as reported by *Dix et al.*[8]. Accurate identification of adverse features, such as extraprostatic extension or seminal vesicle invasion, allows for optimized EBRT planning, including dose escalation or focal boosts to the dominant intraprostatic lesion (DIL)[9,10,16,17]. Additionally, the ability to tailor treatment—including ADT use—based on precise tumor staging likely contributed to the absence of BCR in the MRI-guided group. Major radiotherapy studies have consistently demonstrated that combining EBRT with ADT improves oncologic outcomes, with extended ADT duration and elective pelvic lymph node irradiation offering further benefits[18,19]. While longer follow-up is required to confirm the long-term benefits of MRI-guided biopsy in EBRT, this study highlights its potential to improved bRFS. The observed bRFS in this study aligns with findings from Alexander et al.[20]. , who reported BCR rates of 7% at 3 years and 12.5% at 5 years following EBRT in low- and intermediate-risk patients. Notably, 39.2% of the patients in our study were classified as higher risk, further underscoring the role of MRI-guided biopsy and pre-RT MRI in guiding treatment for this challenging cohort.

While this study demonstrates promising results, several limitations should be considered. First, the retrospective design and the limited number of BCR events ($n = 4$) restrict the ability to draw definitive conclusions through multivariate analysis. Second, the relatively short follow-up period, combined with lack of pre- or post-ERBT serum testosterone measurements, may have led to an underestimation of BCR rates, particularly for patients on prolonged ADT. Third, most MRI-guided biopsies in our institution were performed transperineally, which systematically samples tissues from the anterior and middle zones of the prostate. This differs from traditional TRUS-guided biopsies (TRUS-Bx) and may affect comparability. Additionally, the exclusion of patients with PSA levels ≥ 20 ng/mL limits the applicability of our findings to very high-risk populations, where treatments with ARPIs, such as abiraterone acetate, could play a significant role. Future studies should investigate whether the benefits of MRI-guided biopsy extend to these more aggressive cohorts.

Finally, as a single-center study, potential biases related to patient selection and treatment protocols must be considered. Although all patients underwent MRI simulation as part of EBRT planning, the generalizability of our findings may be limited to institutions where MRI is routinely integrated into clinical workflows. Larger, multicenter prospective studies with longer follow-up periods are necessary to validate our results and assess long-term oncologic outcomes. Furthermore, while PSMA PET/CT has demonstrated value in detecting lymph node involvement and distant metastases[21], its role in guiding localized biopsies remains complementary to MRI. Additional research is warranted to better define its impact on risk stratification and treatment planning.

Conclusion

This study supports the growing body of evidence that MRI-guided biopsy improves treatment outcomes in patients with localized PCa, particularly those undergoing EBRT. Incorporating MRI into the diagnostic and treatment planning process allows for more accurate risk stratification and the optimization of RT delivery and informs appropriate ADT prescription, especially for intermediate-risk patients, to reduce the risk of recurrence. Further research through larger, multicenter trials is essential to validate these findings and assess the broader applicability of MRI-guided biopsy across different risk populations.

Data availability

The data from this study are not deposited in a publicly accessible repository. However, the data will be made available upon request for academic purposes. Please contact T.H. (the corresponding author) for further details.

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Author contributions

K.M. conducted the investigation, performed formal analysis, and wrote the original draft of the manuscript. A.T. contributed to the conceptualization of the study, provided resources, and contributed to the review and editing of the manuscript. V.W. and S.S. provided resources for the study. T.H. was responsible for the conceptualization and methodology, provided resources, and contributed to the review and editing of the manuscript. All authors reviewed and approved the final manuscript.

Declarations

Competing interests
The authors declare no competing interests.

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