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Original Article

Multiparametric MRI in prostate cancer active surveillance: results from the Miami Active Surveillance Trial (MAST) trial

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Objectives

To examine the role of multiparametric magnetic resonance imaging (mpMRI) in enhancing prostate cancer (PCa) detection and selecting candidates for active surveillance (AS), given that its utility in monitoring disease progression remains unclear.

Patients and Methods

The Miami Active Surveillance Trial (MAST) is a prospective trial of men undergoing serial mpMRI and biopsies on AS for PCa. Participants had annual mpMRI with MRI-targeted and systematic biopsies at confirmatory (12–18 months) and subsequent intervals (12, 24, and 36 months). Grade progression was defined as an upgrade from Grade Group (GG) 1 to GG ≥2 or GG 2 to GG ≥3. The performance of MRI was evaluated at baseline (prior to confirmatory biopsy) and on subsequent biopsies for association with grade progression. Fine and Gray competing-risk models evaluated MRI for predicting grade progression after controlling for risk factors.

Results

Among 205 men, 79 (38.5%) had grade progression at the conclusion of the trial (36 months), with 40 (19.5%) men having grade progression at confirmatory biopsy, and the remaining 39 (2.0–9.8%/year) progressing on subsequent biopsies. A Prostate Imaging-Reporting And Data System (PI-RADS) score of 4 or 5 (vs no suspicious lesions or PI-RADS 1 and 2) on baseline MRI (prior to confirmatory biopsy) was an independent predictor of grade progression on confirmatory biopsy (Gray's test $P < 0.001$), with volume progression treated as a competing risk. At 36 months, MRI-only surveillance would have avoided 45% of biopsies but missed 32% of progression events.

Conclusion

Pre-confirmatory biopsy MRI independently predicted grade progression on confirmatory and subsequent biopsies during AS; however, false positives and negatives still occur highlighting the need for periodic biopsy of the prostate.

Keywords

active surveillance, grade progression, magnetic resonance imaging, prostate cancer, PI-RADS, surveillance protocols, imaging predictive value, MRI-guided monitoring

Introduction

Active surveillance (AS) is widely regarded as the preferred management strategy for men with low to favourable intermediate-risk prostate cancer (PCa), allowing treatment to be safely deferred without compromising cancer control [1]. While various protocols differ in their intensity of surveillance, they advocate for routine periodic biopsy of the prostate, which can be burdensome for patients and comes with added risks of infection, bleeding, and urinary complications [2].

Multiparametric MRI (mpMRI) of the prostate has improved the detection of PCa. Numerous randomised trials have supported the use of mpMRI and MRI-targeted biopsy during the initial evaluation of PCa, citing increased detection of significant cancers, fewer biopsies taken, and reduced detection of indolent cancers [3,4]. Consequently, many institutions have incorporated mpMRI into their AS protocols to reduce the frequency of biopsies and enhance the negative predictive value (NPV) for ruling out cancer progression [5].

However, there is concern about the ability of mpMRI to reliably detect progression, leading to variability in the timing and frequency of surveillance biopsies. While most patients would favour an imaging-based approach for surveillance, with biopsies being taken only when there is evidence of progression on imaging, there is concern that some men may compromise their cancer control by missing progression when it occurs and lose their opportunity for curative treatment [6]. Furthermore, most studies evaluating MRI in AS have limited follow-up past the first or second AS biopsy. The Miami Active Surveillance Trial (MAST) is a prospective trial that followed men undergoing AS on a rigorous protocol that involves annual mpMRI and biopsy of the prostate for at least 4 years after diagnosis. The trial has completed its accrual and follow-up, and we report our findings regarding the utility of mpMRI in detecting early and late grade progression during AS.

Patients and Methods

The MAST trial is a prospective, single-centre, single-arm trial (clinicaltrials.gov identifier: NCT02242773) for men with low to favourable intermediate-risk PCa undergoing AS. The study was approved by the University of Miami Institutional Review Board (IRB #20140372).

Enrolment Criteria

Eligibility required biopsy confirmed adenocarcinoma of the prostate with no more than four cores of cancer and no more than two cores of Grade Group (GG) 2. Patients with GG ≥3 PCa, PSA level >20 ng/mL, or clinical suspicion of T3 disease on DRE were excluded. There were no exclusions based on the percentage of cancer in each core or the presence of cribriform pattern. A diagnostic biopsy with a minimum of eight cores was required for enrolment, and all slides were centrally reviewed by a genitourinary pathologist (O.N.K.) at the University of Miami.

External pathology interpretations from referring institutions were not recorded in the database, and only the internal pathology review was used to represent the diagnostic biopsy and determine trial eligibility. Information regarding the use of MRI-targeted biopsies prior to the diagnostic biopsy was not recorded, as MAST trial enrolment began after diagnosis. Additionally, time zero in our study corresponds to the time of diagnostic biopsy.

Imaging and Biopsy Protocol

All patients underwent 3-T mpMRI without using an endorectal coil, along with a confirmatory biopsy within 12–18 months of diagnosis. The imaging protocol consisted of tri-planar T2-weighted (T2W) MRI of the male pelvis, diffusion-weighted imaging (DWI) with a high b-value of 1400 s/mm^2, the corresponding apparent diffusion coefficient map, and dynamic contrast-enhanced (DCE) images. Scanners used in the study included the Discovery MR750 (GE, Waukesha, WI, USA) and the Magnetom Trio, Skyra, and Symphony (Siemens, Erlangen, Germany). Confirmatory biopsy of the prostate included both MRI targeted and systematic biopsy of the prostate. For patients with a Prostate Imaging-Reporting And Data System (PI-RADS) score of ≥3, at least two targeted cores were obtained per MRI-identified lesion in addition to a 12-core extended template biopsy [7–9]. If the mpMRI showed no suspicious lesions (i.e., PI-RADS score 1–2), only the standard 12-core biopsy was performed. Patients without grade progression and who did not undergo treatment were followed annually with similar mpMRI and biopsy protocols for an additional 3 years. PSA levels were measured every 6 months.

Definition of Grade Progression

Grade progression was defined as an increase from GG 1 to GG ≥2 for patients who entered the trial with GG 1 disease and progression to GG ≥3 for those with GG 2 disease at baseline. It should be noted that volume progression was considered a competing factor for grade progression. In particular, patients with more than four positive biopsy cores of any Gleason grade, or more than two cores positive for GG 2, could have progressed to definitive treatment.

The MRI Assessment and Analysis

To mitigate concerns regarding variability in MRI interpretation, we applied a standardised approach to interpreting all mpMRIs using the most recent version of

PI-RADS available at the time. As PI-RADS scores underwent revisions during the course of the trial, we adapted and implemented the updated standards as they were introduced. Interpretations were performed by 11 fellowship-trained radiologists (median [range] experience 10 [3–20+] years), each of whom had interpreted >1000 prostate MRI cases, consistent with European Society of Urogenital Radiology (ESUR)/European Association of Urology Section of Urological Imaging (ESUI) consensus guidelines [10]. Interval changes in MRI were categorised as MRI progression if the PI-RADS score increased at all, or no MRI progression if the PI-RADS score decreased or remained stable. This study began prior to the Prostate Cancer Radiological Estimation of Change in Sequential Evaluation (PRECISE) criteria being made available. Additional analysis was conducted using the PI-RADS score of the most current MRI prior to biopsy, without accounting for any change compared to the previous MRI.

Statistical Analysis

Continuous variables, such as PSA and prostate volume, were reported as medians with interquartile ranges (IQRs) while categorical variables, such as ethnicity and National Comprehensive Cancer Network (NCCN) risk group, were reported using the number and proportion of patients in each category. Grade progression was analysed at each biopsy time point, and the proportion of patients experiencing grade progression was compared between the MRI progression and no MRI progression groups. Because participants with earlier grade progression were no longer present at later biopsy time points, these were treated as independent subsets rather than paired observations. *P* values were calculated using Fisher's exact test. Uni- and multivariate Fine and Gray competing-risk analyses were conducted to predict the risk of grade progression at confirmatory biopsy and any subsequent surveillance biopsy, controlling for clinical, biochemical, and radiological factors. In these analyses, volume progression was treated as a competing risk for grade progression as several patients were treated for volume progression before they progressed to grade progression; however, these patients are also most likely to experience grade progression. Patients who underwent radical prostatectomy for volume progression were considered grade progression if they were found to have upgraded in the surgical specimen but were considered only volume progression if they did not have an upgrade or were treated with radiation. Subdistribution hazard ratios with 95% CIs were reported and can be interpreted as the relative effect of the covariates on the cumulative incidence of grade progression compared to patients who are event-free or who have experienced volume progression. A $P < 0.05$ was considered statistically significant. All statistical analyses were performed using the Statistical Analysis System (SAS) version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

A total of 205 men diagnosed with low to favourable intermediate-risk PCa were enrolled between 2014 and 2020. Table 1 shows the descriptive characteristics of the entire cohort, with comparisons between the grade progression and non-grade progression groups. The median (IQR) age of participants was 62 (56–68) years, and the median (IQR) PSA level was 5 (3.7–7) ng/mL. The median (IQR) follow-up time from the initial biopsy for participants who completed the trial without grade progression was 3.8 (3.6–4.0) years. In our cohort, 90.24% (185/205) of patients had at least 12 cores taken on diagnostic biopsy, with a median (IQR) of 12 (12–14) cores. There was no concerning difference in baseline characteristics between men lost to follow-up and those who completed the study (Table S1). Of the cohort, 172 men (83.9%) were classified as very low or low risk according to NCCN risk stratification, and the majority (94%) had GG 1 disease. Among these men, 42 patients (20.5%) had MRIs that did not show any suspicious lesions (i.e., PI-RADS score 1–2) on their pre-confirmatory biopsy MRI, while 58 (28.3%), 87 (42.4%), and 18 (8.8%) had PI-RADS scores of 3, 4, and 5, respectively.

Figure 1 provides a flowchart of patient progression through the study protocol, indicating the number of patients who experienced grade progression at each biopsy time point. Of the 205 participants, 79 (38.5%) experienced grade progression. Grade progression was identified in 40 patients (19.5%) at the confirmatory biopsy, while an additional 20 (10%), 15 (7%), and four (2%) demonstrated progression at the 12-, 24-, and 36-month biopsies, respectively.

Fig. S1 shows the descriptive proportion of patients who experienced grade progression by PI-RADS score at confirmatory biopsy and by a change in PI-RADS score at each subsequent biopsy. Stratified follow-up outcomes by baseline PI-RADS score are shown in Table S2, which suggests more progression in stable PI-RADS score 4–5 and PI-RADS score 3 compared to no suspicious lesions; however, the cohort sample sizes are small, limiting statistical comparison. Cumulative incidence estimates for grade and volume progression at 12, 24, and 36 months, stratified by baseline MRI findings, are shown in Table 2. The competing-risk analysis demonstrated a significant difference in cumulative incidence of grade progression by baseline PI-RADS score category (Gray's test $P = 0.005$). It should be noted that volume progression was treated as a competing risk for grade progression. Four cases of grade progression occurred in patients with no suspicious lesions (i.e., PI-RADS score 1–2) prior to confirmatory biopsy, one of whom had progressed to GG 3 disease on confirmatory biopsy. In this patient, he had two cores of GG 1 at diagnosis, with 16 months between diagnostic biopsy until confirmatory biopsy. Among patients with an initial PI-RADS score of 3–5,

Table 1 Baseline patient characteristics.

Characteristic	Whole cohort	No grade progression	Grade progression
All, *n* (%)	205 (100)	126 (100)	79 (100)
Age, years, median (IQR)	62 (56–68)	61.5 (56–67)	64 (58–70)
<65 years, *n* (%)	122 (59.5)	82 (65.1)	40 (50.6)
≥65 years, *n* (%)	83 (40.5)	44 (34.9)	39 (49.4)
Race, *n* (%)			
White	183 (89.3)	110 (87.3)	73 (92.4)
Black/Asian	22 (10.7)	16 (12.7)	6 (7.6)
Hispanic ethnicity	87 (42.4)	52 (41.3)	35 (44.3)
NCCN risk at enrolment, *n* (%)			
Very low	94 (45.9)	74 (58.7)	20 (25.3)
Low	78 (38)	40 (31.7)	38 (48.1)
Intermediate	33 (16.1)	12 (9.5)	21 (26.6)
GG at diagnosis, *n* (%)			
GG 1	193 (94.1)	125 (99.2)	68 (86.1)
GG 2	12 (5.9)	1 (0.8)	11 (13.9)
Baseline PSA level, ng/mL, median (IQR)	5 (3.7–7.0)	4.6 (3.22–6.7)	5.7 (4.3–7.8)
Prostate size, mL, median (IQR)	45 (33.59–62)	47.73 (34–66)	42 (31.8–53)
PSA density, ng/mL/mL, median (IQR)	0.11 (0.07–0.17)	0.09 (0.06–0.14)	0.13 (0.08–0.20)
<0.15 ng/mL/mL, *n* (%)	141 (68.8)	97 (77)	44 (55.7)
≥0.15 ng/mL/mL, *n* (%)	64 (31.2)	29 (23)	35 (44.3)
Pre-confirmatory PI-RADS score, *n* (%)			
≤2	42 (20.5)	33 (26.2)	9 (11.4)
3	58 (28.3)	44 (34.9)	14 (17.7)
4	87 (42.4)	42 (33.3)	45 (57)
5	18 (8.8)	7 (5.6)	11 (13.9)

23.3% experienced grade progression, compared to only 4.8% of patients with no suspicious lesions (i.e., PI-RADS score 1–2, $P = 0.007$). Following enrolment, patients with an increase in their PI-RADS score at 12 months had a 30% rate of grade progression compared to 12.1% in those with stable or decreasing PI-RADS scores ($P = 0.043$). However, this difference did not persist or reach statistical significance in the second and third years of follow-up.

We performed analysis using the MRI prior to confirmatory biopsy instead of modelling MRI as a change in PI-RADS score and found PI-RADS score 3–5 to be a significant predictor of grade progression on subsequent biopsy compared to men with a MRI that had no suspicious lesions (i.e., PI-RADS score 1–2, Table 3).

Biopsies conducted in the first and second years following the confirmatory biopsy detected grade progression in 16.5% (20/121) and 17.2% (15/87) of cases, respectively, with no statistically significant difference ($P = 0.9$). However, grade progression was detected in only 7% (4/56) of cases during the third year of follow-up.

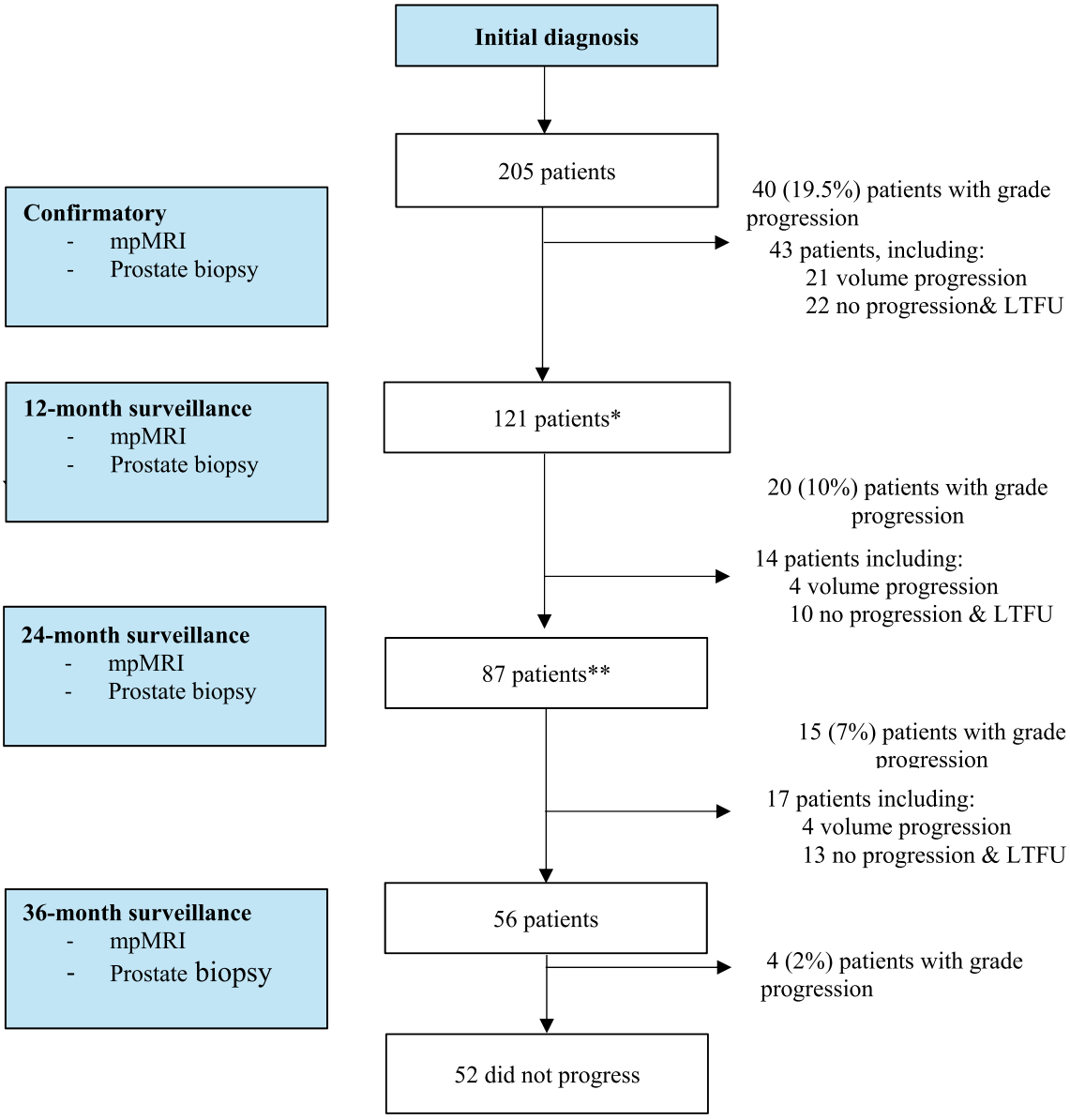
Table S3 presents the sensitivity, specificity, positive predictive value (PPV), and NPV at each biopsy time point. We noticed a significant decrease in the sensitivity of detecting grade progression from the confirmatory biopsy to the subsequent biopsies. This was paired with a complementary increase in specificity. While the NPV and PPV appeared visually stable over the study period, these metrics are inherently dependent on the underlying disease prevalence, making direct statistical comparison across time points inappropriate.

We evaluated various MRI and biopsy protocols for AS monitoring after confirmatory biopsy. We reported the number of biopsies that would have been avoided, as well as the instances of missed grade progression under different scenarios. Taking biopsies based solely on MRI findings would have significantly reduced surveillance biopsies, with 209 of 469 (45%) biopsies avoided. However, this would have come at the cost of missing 25 of 79 (32%) cases of grade progression. If only the confirmatory and 3-year surveillance biopsy had been taken instead of annual biopsies done in between, grade progression would have been missed in 35 (44%) cases. Of these, 20 (25%) patients would have delayed the detection of progression for 2 years and 15 (19%) for 1 year (Fig. 2).

Discussion

The role of MRI in AS has expanded with benefits in the initial selection as well as monitoring of patients. Incorporating MRI and MRI-guided biopsy into AS protocols has allowed more certainty about the absence of higher-grade cancer, allowing expansion of eligibility criteria [11,12]. While many guidelines recommend the use of MRI in the initial evaluation and follow-up of men on AS, significant variability exists in how MRI is utilised [13,14]. While an individualised monitoring approach for each patient based on risk factors

Fig. 1 Study schema. Percentages from a total of 205 patients. LTFU: lost to follow-up. *, One patient is excluded in *n* = 121 at 12 months but included in *n* = 87 at 24 months. **: One patient is excluded in *n* = 87 at 24 months but included in *n* = 56 at 36 months. *Patient identifier (PtID) 59 missed the 12-month visit; however, the patient returned to 24-month visit and biopsy showed grade progression. **PtID 20 missed the 24-month visit; however, the patient returned to 36-month visit and biopsy result showed no progression.



for progression and goals of care is ideal, no universally accepted guidelines define the optimal timing for follow-up MRI and biopsies.

Reported biopsy schedules in AS cohorts vary from every 1–4 years, with mpMRI intervals ranging from every 12–24 months [15–17]. For example, the Canary Prostate Active Surveillance Study (PASS), a large multicentre prospective cohort, took biopsies at 6–12 and 24 months after diagnosis, with subsequent biopsies taken every 2 years, while MRI was performed at the clinician's discretion. They reported a NPV of mpMRI of 83% (95% CI 76–90%) for detecting GG ≥2 cancer [18]. Similarly, in a prospective cohort from the National Institutes of Health (NIH), the NPV of mpMRI for detecting GG ≥2 was 0.76 (95% CI 0.71–0.81) [19]. However, in each of these cohorts, there are instances where a MRI was performed without a subsequent biopsy, complicating the evaluation of NPV. In our cohort, we conducted mpMRI and biopsies every year, regardless of MRI findings, allowing us to know the true status of progression after each MRI. We reported a NPV of 95.2%

Table 2 Cumulative incidence of grade and volume progression at confirmatory, 12-, 24-, and 36-month biopsy stratified by baseline MRI PI-RADS findings at time zero.

Time point	PI-RADS score 0–2, % (95% CI) (*n* = 42)	PI-RADS score 3–5, % (95% CI) (*n* = 163)
Confirmatory		
Volume progression	4.9 (0.9–14.7)	6.6 (3.4–11.4)
Grade progression	2.4 (0.2–10.9)	20.6 (14.5–27.4)
12-month		
Volume progression	4.9 (0.9–14.7)	12.4 (7.6–18.4)
Grade progression	11.6 (3.5–24.8)	34.3 (26.6–42.0)
24-month		
Volume progression	4.9 (0.9–14.7)	13.2 (8.2–19.3)
Grade progression	22.4 (9.5–36.7)	45.3 (36.8–53.4)
36-month		
Volume progression	10.1 (2.1–25.6)	15.1 (9.7–21.7)
Grade progression	30.9 (12.0–52.1)	52.8 (42.8–62.0)

Table 3 Uni- and multivariate Fine-Gray models assessing association between baseline clinical factors (known prior to confirmatory biopsy) and grade progression (*N* = 205 with 79 grade progressions).

Factor	Unit/category	Subdistribution hazard ratio (95% CI)	*P*
Univariate models			
Age	1-unit increase	1.05 (1.02–1.08)	**0.002**
	≥65 vs 65 years (ref)	1.80 (1.16–2.79)	**0.009**
NCCN risk	Low vs very low (ref)	2.64 (1.55–4.49)	**<0.001**
	Inter vs very low (ref)	4.16 (2.27–7.62)	**<0.001**
PSA density	0.1-unit increase	1.56 (1.32–1.85)	**<0.001**
	≥0.15 vs 0–0.15 ng/mL/mL (ref)	2.09 (1.34–3.25)	**0.001**
PI-RADS score	3 vs ≤2 (ref)	4.30 (1.43–12.95)	**0.010**
	4 vs ≤2 (ref)	11.05 (3.95–30.96)	**<0.001**
	5 vs ≤2 (ref)	11.47 (3.94–33.42)	**<0.001**
PI-RADS score	4/5 vs ≤3 (ref)	4.50 (2.69–7.54)	**<0.001**
Multivariate model			
Age	≥65 vs 65 years (ref)	1.37 (0.89–2.11)	0.150
NCCN risk	Low vs very low (ref)	1.67 (0.91–3.06)	0.097
	Inter vs very low (ref)	2.53 (1.27–5.04)	**0.009**
PSA density	≥0.15 vs 0–0.15 ng/mL/mL (ref)	1.19 (0.72–1.95)	0.502
PI-RADS score	3 vs ≤2 (ref)	3.52 (1.19–10.35)	**0.023**
	4 vs ≤2 (ref)	7.92 (2.86–21.92)	**<0.001**
	5 vs ≤2 (ref)	8.62 (3.03–24.55)	**<0.001**

Volume progression treated as a competing risk for grade progression.
Bold values statistically significant at $P < 0.05$.

(95% CI 84–98%) for confirmatory biopsies and 88% (95% CI 83–92%) for subsequent biopsies, which aligns with a meta-analysis by Guo et al. [20] (pooled NPV: 91%). We expected the NPV to increase with time due to a reduction in the number of prevalent significant cancers in the cohort and the results of a previous study by Chu et al. [21], that demonstrated the prognostic value of MRI improves with repeated use. However, we found that the NPV and PPV for MRI remained unchanged throughout the study. We acknowledge that there may have been a difference that we were not powered to detect.

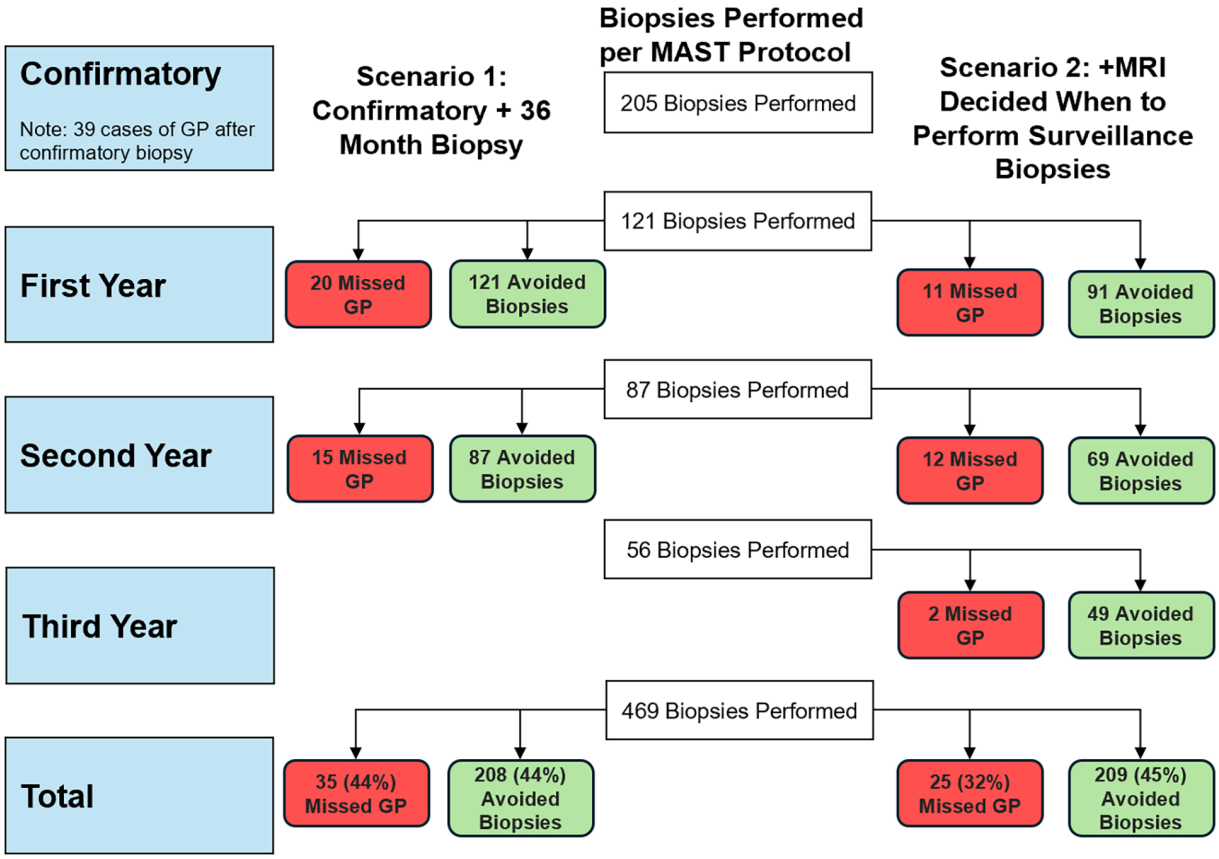
Patients who do poorly on AS are often those misclassified at the time of diagnosis. While advances in MRI and MRI-guided biopsy have significantly reduced the number of such cases, misclassification still occurs in a small subset of patients. In a cohort from the NIH, it was reported that 22% (33/149) of cases with grade progression would have been missed if 2-year follow-up biopsies had been taken only when there was a positive change on MRI [19].

We noticed that if surveillance biopsies were taken only when there was evidence of progression on MRI, we would have missed 12.1% (11/91) of patients with grade progression in the first year and 17.4% (12/69) in the second year among those for whom biopsies were avoided. In the third year of follow-up, this proportion would have decreased to 4% (2/49), suggesting that an image-based approach to subsequent surveillance biopsies may be more appropriate in the later years (Fig. 2). Our results align with recent review articles concluding that MRI cannot fully replace biopsy but does provide value when combined with clinical and pathological information [22,23]. These authors also argue that AS protocols should be tailored to local diagnostic performance rather than relying solely on international standards [22].

Although an increasing PI-RADS score was independently associated with a higher risk of grade progression in our cohort, false positives were a notable issue, as more than two-thirds of patients with increasing PI-RADS scores did not experience grade progression on biopsy. Artificial intelligence tools are emerging to enhance MRI interpretation, reduce inter-reader variability, and improve the detection and exclusion of grade progression. For instance, we have developed in-house software for MRI interpretation, the Habitat Risk Score (HRS), and are currently evaluating its performance in this cohort [24]. The HRS is an MRI-based biomarker that quantifies intertumoral heterogeneity by integrating features from T2W, DWI, and DCE sequences [24]. It produces a composite score associated with clinically significant PCa, helping identify higher-risk patients on AS [24].

Our study had several strengths. Most notably, it included a cohort of >200 patients who were followed using a prospective protocol incorporating annual MRI and biopsy, providing valuable insights into MRI performance as a monitoring tool for detecting grade progression. Additionally, our cohort was diverse, with >42% of participants self-identifying as Hispanic, providing unique and valuable data on an underrepresented population of men choosing AS. Finally, all pathology was centrally reviewed at enrolment by a single genitourinary pathologist (O.N.K.). However, the

Fig. 2 Comparison of the number of biopsies avoided after confirmatory biopsy and the cases that would have been missed under different scenarios.



study does have some limitations, including a relatively small sample size and single-centre design. This study began before the establishment of the PRECISE criteria and later PRECISE version 2, which have since been adopted by many studies to standardise MRI findings and minimise diagnostic errors when interpreting MRI for AS patients [25,26]. Nevertheless, a meta-analysis of 15 studies involving 2240 patients conducted by Rajwa et al. [27] found no significant differences in the pooled sensitivity and specificity between PRECISE and institution-specific lesion definitions. Furthermore, the radiologist who reviewed the initial MRI was not always the same person who interpreted subsequent MRIs, which may have introduced inter-reader variability. This is of course important because PRECISE version 2 recommends that the same reader evaluate scans to ensure consistency [26]. While this limitation affects the consistency of our analysis, we believe it enhances the generalisability of our findings to real-world practice, where radiology workflows rarely allow the same radiologist to interpret follow-up scans for each patient. We acknowledge that the dropout rate was relatively high, and this was due to our definition of volume progression and patients were excluded if they had more than four positive cores of any Gleason score, or more than two positive cores for Gleason 3 + 4 cancer, which led to those patients receiving definitive treatment and pathological data were unavailable for patients who discontinued follow-up and proceeded to radiotherapy. Lastly, only the global PI-RADS score was considered, without accounting for changes in lesion size or the appearance of new lesions with the same PI-RADS score. However, we believe that these limitations align with routine clinical practice, making these results more generalisable to real-world settings.

To conclude, we followed a cohort of >200 men with low to favourable intermediate-risk PCa who enrolled in an AS protocol that involved annual MRI and biopsy of the prostate. We found that a pre-confirmatory biopsy MRI demonstrating PI-RADS score 4 or 5 lesions was a significant predictor of grade progression at confirmatory biopsy and an increase in PI-RADS score on subsequent MRI was a significant predictor of grade progression on subsequent biopsy. Despite this, there were high rates of false positives and negatives that can result in unnecessary biopsies, anxiety, and missed progression that caution a reliance primarily on MRI for detecting progression and support the need for serial surveillance biopsies.

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Disclosure of Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data Availability Statement

The data sets generated during and/or analysed during the present study are available from the corresponding author on reasonable request.

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Abbreviations: AS, active surveillance; DCE, dynamic contrast-enhanced; DWI, diffusion-weighted imaging; GG, Grade Group; HRS, Habitat Risk Score; IQR, interquartile range; MAST, Miami Active Surveillance Trial; NCCN, National Comprehensive Cancer Network; PCa, prostate cancer; PI-RADS, Prostate Imaging-Reporting And Data System; PRECISE, Prostate Cancer Radiological Estimation of Change in Sequential Evaluation; (N)(P)PV, (negative) (positive) predictive value; T2W, T2-weighted.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Fig. S1. Association of PI-RADS score and changes over time with grade progression. The two bars on the left show progression rates by baseline PI-RADS prior to confirmatory biopsy, while the three pairs of bars on the right represent PI-RADS change (stable/decreased vs increased) at the 12-, 24-, and 36-month biopsies. Red = grade progression; Blue = no progression.

Table S1. Baseline characteristics of patients lost to follow-up (LTFU)/volume progression vs patients who completed the whole study.

Table S2. Grade progression (GP) by changing PI-RADS score, stratified based on baseline PI-RADS score.

Table S3. Performance of mpMRI for detecting grade progression. Positive test results were treated as PI-RADS 3–5 at baseline or increase in PI-RADS at the 12-, 24-, and 36-month follow-ups. The 95% CIs were reported for each estimate.

