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Prostate MRI versus PSA screening for prostate cancer detection (the MVP Study): a randomised clinical trial

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ABSTRACT

Objectives Our objective was to compare prostate cancer detection rates between patients undergoing serum prostate-specific antigen (PSA) vs magnetic resonance imaging (MRI) for prostate cancer screening.

Design Phase III open-label randomised controlled trial.

Setting Single tertiary cancer centre in Toronto, Canada.

Participants Men 50 years of age and older with no history of PSA screening for ≥3 years, a negative digital rectal exam and no prior prostate biopsy.

Interventions Patients were recommended to undergo a prostate biopsy if their PSA was ≥2.6 ng/mL (PSA arm) or if they had a PIRADS score of 4 or 5 (MRI arm). Patients underwent an end-of-study PSA in the MRI arm.

Primary and secondary outcome measures Adenocarcinoma on prostate biopsy. Prostate biopsy rates and the presence of clinically significant prostate cancer were also compared.

Results A total of 525 patients were randomised, with 266 in the PSA arm and 248 in the MRI arm. Due to challenges with accrual and study execution during the COVID-19 pandemic, the study was terminated early. In the PSA arm, 48 patients had an abnormal PSA and 28 (58%) agreed to undergo a prostate biopsy. In the MRI arm, 25 patients had a PIRADS score of 4 or 5 and 24 (96%) agreed to undergo a biopsy. The relative risk for MRI to recommend a prostate biopsy was 0.52 (95% CI 0.33 to 0.82, p=0.005), compared with PSA. The cancer detection rate for patients in the PSA arm was 29% (8 of 28) vs 63% (15 of 24, p=0.019) in the MRI arm, with a higher proportion of clinically significant cancer detected in the MRI arm (73% vs 50%). The relative risk for detecting cancer and clinically significant with MRI compared with PSA was 1.89 (95% CI 0.82 to 4.38, p=0.14) and 2.77 (95% CI 0.89 to 8.59, p=0.07), respectively.

Conclusions Prostate MRI as a stand-alone screening test reduced the rate of prostate biopsy. The number of clinically significant cancers detected was higher in the MRI arm, but this did not reach statistical significance. Due to early termination, the study was underpowered. More patients were willing to follow recommendations for prostate biopsy based on MRI results.

Trial registration number NCT02799303.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This is the first randomised trial to directly compare serum prostate-specific antigen (PSA) testing and prostate MRI for prostate cancer screening purposes.
⇒ Participants in each arm did not undergo the reciprocal test at the time of randomisation.
⇒ Limitations of the current study include the conduct of the trial at a single centre and the higher drop-out rate seen in the PSA arm.
⇒ The study was terminated prematurely due to accrual challenges and difficulties accessing MRI resources and PSA follow-up data due to resource limitations and patient reluctance during the COVID-19 pandemic; as a result, the study was underpowered.
⇒ Nevertheless, this randomised trial confirms the utility and public acceptance of the use of MRI in this setting.

INTRODUCTION

The prostate-specific antigen (PSA) blood test continues to be used for prostate cancer screening after randomised clinical trials demonstrated some improvement in prostate cancer mortality rates.[1 2] Several serological and imaging tests have been evaluated to improve its predictive value. Prostate multiparametric MRI (mpMRI) has been examined as an adjunct test to PSA to better identify patients who require a prostate biopsy for the presence of aggressive forms of prostate cancer.[3] Randomised clinical trials have shown that mpMRI can improve the predictive value for the presence of clinically significant prostate cancer, compared with PSA alone.[3]

Although prostate MRI can improve the predictive value of PSA, it is still dependent on the pitfalls of interpreting the initial PSA test. To our knowledge, no randomised controlled trial has directly compared the efficacy between PSA and stand-alone prostate MRI testing (without the influence of PSA) for prostate cancer detection among an unselected cohort of men for prostate

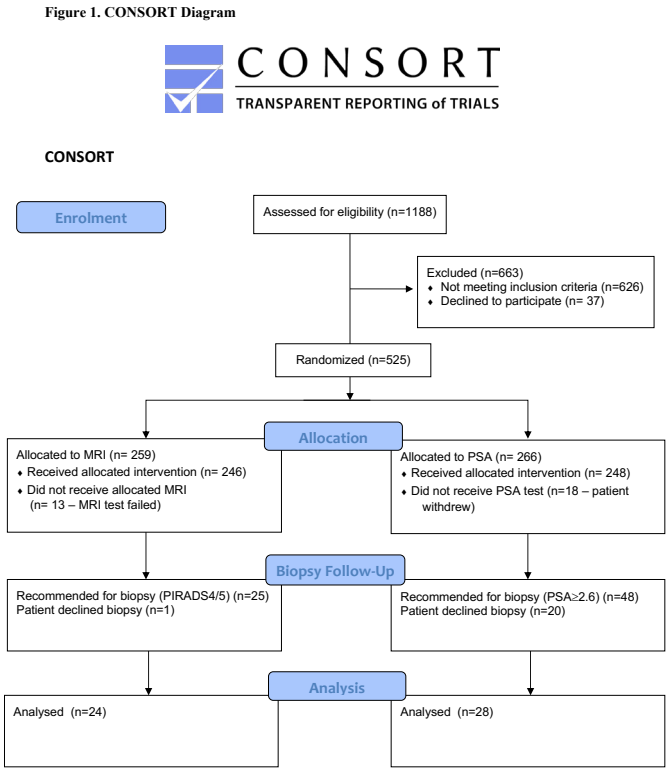

Figure 1 CONSORT diagram. CONSORT, Consolidated Standards of Reporting Trials; PSA, prostate-specific antigen; PIRADS, Prostate Imaging-Reporting and Data System.

cancer screening. It would be important to characterise the predictive value of MRI for the presence of prostate cancer as a stand-alone test without the potential biases that PSA introduces in assessing prostate cancer risk. Thus, we conducted a randomised, phase 3 study comparing prostate cancer detection rates between MRI versus PSA—the MVP study.

MATERIALS AND METHODS

Study design

We conducted a single centre, phase 3, randomised open-label controlled trial comparing MRI of the prostate vs serum PSA testing among eligible men who had not undergone a previous prostate cancer screening evaluation.

The study was registered under ClinicalTrials.gov (NCT02799303, 14 June 2016) and followed the Consolidated Standards of Reporting Trials guidelines (figure 1). Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Participants

Participants were recruited from newspaper and radio advertisements approved by the REB calling for volunteers from the Greater Toronto Area who had not undergone a prostate cancer screening evaluation by their primary physician. Volunteers had to be 50 years or older with a life expectancy of at least 10 years, have no history of any prostate biopsy even if remote, no serum PSA measurement within the last 3 years and no urinary difficulty symptoms (ie, asymptomatic). Subjects who answered the advertisements were invited to be further screened at Sunnybrook Health Sciences Centre. Following informed consent, we accessed the personal province-wide electronic medical record to verify whether each volunteer had previously undergone a PSA test (electronic records report province-wide laboratory records) or a prostate biopsy. Where relevant testing was identified, these individuals were excluded. Patients were further excluded if they had a history of prostate cancer in one or more first degree relatives diagnosed <50 years of age, a urinary International Prostate Symptom Score of ≥8, any prior or current use of 5-alpha reductase inhibitor medications (finasteride or dutasteride), or if they had a history of claustrophobia or other medical indication which would preclude undergoing an MRI. After all exclusions were considered, subjects then underwent digital rectal examination (DRE) and any subjects with an abnormal DRE were excluded and referred to their primary physician for further management. The DRE was completed by a medical doctor at Sunnybrook Health Sciences Centre with expertise in treating prostate cancer. Given the expertise of the staff, we do not expect any bias to be caused by the performance of the DRE by different providers as this is a standard part of assessment of all patients.

Randomisation and masking

Patients were randomised in a 1:1 ratio using a computerised random generator and the group assignment was revealed once a patient was deemed eligible and had provided written informed consent.

PSA arm

Patients randomised to the PSA arm underwent a PSA blood test performed by provincially licensed laboratories. All provincial laboratories in Ontario are regulated by the province to ensure they meet quality standards. PSA tests were not centrally performed. Patients with PSA levels of≥4.0 ng/mL were recommended to undergo a transrectal ultrasound (TRUS)-guided prostate biopsy with a minimum of 12 needle-core biopsy template. A total of 12 cores were taken for all systematic biopsies. If the physician completing the biopsy noted a lesion on TRUS, this could be sampled and was at the discretion of the treating provider. Patients with a PSA level between 2.6 ng/mL and 4.0 ng/mL were offered TRUS-guided prostate biopsy based on past studies showing a significant prevalence of prostate cancer among that range.[4] A biopsy was not mandated for this range since the largest North American randomised PSA screening study used a PSA cut-off level of 4.0 ng/mL as the standard-of-care.[1] Patients with a normal PSA underwent annual PSA testing for 3 years.

MRI Arm

Patients randomised to the MRI arm underwent biparameteric prostate MRI (bpMRI) testing at our centre (see online supplemental appendix 1). No PSA test was performed. Prostate MRI examination was performed on a 3T Siemens Magnetom Prisma Scanner Software V.E11 (Siemens Healthcare, Erlangen, Germany) without an endorectal coil. All exams were performed on the same scanner and software version. No intravenous contrast or other medication was administered for the MRI study. Multiparametric MRI is a combination of T2-weighted imaging, diffusion-weighted imaging (DWI) and dynamic contrast-enhanced imaging (DCEMRI). Biparametric MRI where no contrast agent is given and only T2 and DWI are performed is advocated as a more cost-efficient approach in prebiopsy scenarios[5] and was used in this study. In cases where there was a poor-quality exam precluding interpretation of DWI, the patient was called back and the exam repeated.

The bpMRI was read by one uroradiologist (MAH) with 20 years of experience interpreting prostate MRI. The presence or absence of up to four cancer targets was scored on a 5-point scale using the Prostate Imaging-Reporting and Data System (PIRADS) V.2.1 guidelines modified for bpMRI interpretation[6] with one being 'clinically significant disease is highly unlikely to be present' and five being 'clinically significant disease is highly likely to be present' determined by a composite of T2 and DWI appearances. As DCEMRI only affects the composite PIRADS score by potentially increasing the score from 3 to 4 when there is a PIRADS 3 DWI lesion, lesions with a PIRADS 3 score on DWI were simply kept as 3. The scoring scheme was otherwise identical to PIRADS as used in mpMRI.

The study protocol was amended prior to enrolment to require biopsy only among men in the MRI arm with PIRADS 4 or 5 lesion(s) (previously 3, 4 or 5). Patients with significant lesions were recommended for targeted biopsy using ultrasound-MRI fusion directed biopsies using a biopsy fusion system (Artemis, Eigen, Grassy Valley, California, USA) in addition to systematic 12-core prostate biopsy. Four cores were performed for the primary target and up to 4 cores were allowed for secondary targets, which was at the discretion of the physician performing the biopsy based on size, position and expertise in whether the lesion had been appropriately sampled. All patients were followed in the same urology clinic where the accrual process had been completed by the same provider on an annual basis for clinical assessment. An end-of-study PSA was recommended to all patients in the MRI arm.

Outcomes

The primary endpoint was the presence of adenocarcinoma on prostate biopsy (International Society of Urological Pathology [ISUP] grade group 1 and above). The presence of clinically significant cancer was defined as patients with a Gleason score of 7 or greater (ISUP grade group 2 and above). All prostate biopsies were read by genitourinary cancer pathologists to assign a Gleason score pattern. Gleason score was assigned based on a combination of the most common and highest Gleason score on prostate biopsy. All cores (systematic and targeted if the patient was in the MRI group) were considered together and not separately. All biopsy discussions took place between the patients and a single physician expert with over 20 years of experience in treating prostate cancer. All patients diagnosed with prostate cancer were referred for consultation with a urologist and a radiation oncologist for subsequent management.

Statistical analysis

Based on our previous pilot study,[7] we anticipated 14% of patients in the PSA group and 21% of those in the MRI group would be diagnosed with cancer. Based on an alpha=0.05 and beta=0.20 (power=0.80) and a superiority design, we estimated that 918 patients in total (459 in each arm) would be required and allowing for a 10% drop-out rate, we needed to recruit a total of 1010 patients.

A planned interim analysis was conducted by the study's lead coprincipal investigators (RN and MAH) when half of the expected accrual was completed. The study had to be closed prematurely due to accrual challenges and difficulties accessing MRI resources and PSA follow-up data due to resource limitations and patient reluctance during the COVID-19 pandemic. As a result, the study was underpowered.

Baseline distributions of PSA levels and MRI PIRADS scores were examined. Baseline characteristics that were continuous were presented as mean with SD and compared using the Student's t-test. Categorical variables were compared by using the χ^2 test. Patients who dropped out of the study because they declined to undergo a prostate biopsy based on PSA or MRI results were included as part of an intent-to-treat analysis when comparing cancer detection rates between each arm. To estimate relative risks and 95% CIs for our primary and secondary outcomes, a 2×2 comparison was performed between the PSA and MRI groups. A $p<0.05$ was used to indicate statistical significance for a two-tailed comparison. All analyses were performed by using the SAS V.9.

RESULTS

A total of 1188 subjects volunteered to participate in the study and were assessed for eligibility. On screening with a review of their electronic medical record, 663 were excluded (figure 1), leaving 525 subjects for randomisation. Of the 266 patients randomised to the PSA arm, 18 patients withdrew after being informed they would not get an MRI, leaving 248 (93%) patients for analysis. Of the 259 patients randomised to the MRI arm, the MRI test was not completed on 13 patients due to claustrophobia, leaving 246 (95%) for analysis.

The baseline characteristics between patients in the PSA and MRI arms were similar (table 1). Of the 248 patients

Table 1 Comparison of baseline characteristics between PSA and MRI arms

Characteristic	PSA arm (n=248)	MRI arm (n=246)
Age (years) (mean±SD deviation)	67.5±7.8	67.7±7.3
Ethnic background (%)		
White	211 (85.1)	207 (84.2)
Black	4 (1.6)	1 (0.4)
Asian	9 (3.6)	19 (7.7)
Other	24 (9.7)	19 (7.7)
PSA distribution (%)		
<2.6 ng/mL	200 (80.6)	
2.6–4.0 ng/mL	30 (12.1)	
4.1–10.0 ng/mL	15 (6.0)	
10.1–20.0 ng/mL	3 (1.2)	
MRI PIRADS score distribution (%)		
1		6 (2.4)
2		183 (74.4)
3		32 (13.0)
4		22 (8.9)
5		3 (1.2)

.PIRADS, Prostate Imaging-Reporting and Data System; PSA, prostate-specific antigen.

in the PSA arm, the median PSA level was 1.26 ng/mL (IQR 0.72–2.16 ng/mL). Most patients had a PSA level of <2.6 ng/mL (n=200, n=80.6%) (table 1), while 48 (19.4%) had a PSA ≥2.6 ng/mL. Of the 48 patients with PSA≥2.6 ng/mL, 28 (58%) agreed to undergo a prostate biopsy. Of the 246 patients in the MRI arm, most patients had a PIRADS score of 1, 2 or 3 (n=221, 89.8%). A total of 25 patients (10.1%) had a PIRADS score of 4 or 5 and were recommended prostate biopsy (table 1), and 24 (96%) agreed to undergo a biopsy. The relative risk for MRI to recommend a prostate biopsy was 0.52 (95% CI 0.33 to 0.82, p=0.005) compared with PSA.

The positive predictive value of PSA was significantly lower than MRI on per protocol (8/28 (28.6%) vs 15/24 (62.5%), p=0.019) and intention-to-treat analysis (8/48 (16.7%) vs 15/25 (60.0%), p<0.001). The proportion of patients diagnosed with prostate cancer who had ISUP grade group 2 or higher disease was greater among the patients in the MRI arm compared with the PSA arm (73.3% vs 50.0%) (table 2). The relative risk for detecting cancer with MRI was 1.89 (95% CI 0.82 to 4.38, p=0.14) while the relative risk for detecting clinically significant cancer (ISUP grade group 2 or more) with MRI was 2.77 (95% CI 0.89 to 8.59, p=0.07) vs PSA.

We obtained end-of-study PSA tests among patients in the MRI arm. However, due to COVID-19 pandemic-related restriction, we obtained PSA results on only 117 of the 246 in the MRI arm. Patients who had a higher PIRADS score on MRI were more likely to have had an end-of-study PSA (93/221 of patients with a PIRADS 1–3 lesion had an end-of-study PSA vs 24/25 of patients with a PIRAD 4–5 lesion, p<0.001).

When we examined the distribution of PSA categories by MRI PIRADS scores, there were significant discordances of which patients were considered normal or abnormal by the PSA or MRI categories (table 3). Among patients in the MRI group considered to have normal PSA level (<2.6 ng/mL), 13.3% had a PIRADS score 4 or 5 lesion and 61.8% patients considered to have an abnormal PSA level had a PIRADS score of 1–3 (p<0.002) (table 3). Of the 11 patients who had a PSA <2.6 ng/mL and a PIRADS score of 4 or 5, three patients (27%) had cancer; two patients had Gleason score 7 and the other had Gleason score 6 disease. If we use MRI as the reference to undergo a prostate biopsy, the relative risk of PSA potentially missing a prostate cancer was 1.69 (95% CI 1.6 to 10.4) and the relative risk of unnecessary biopsy based on PSA was 2.40 (95% CI 1.4 to 4.1).

DISCUSSION

Statement of principal findings

From this randomised controlled study where patients underwent a stand-alone PSA or prostate MRI test for prostate cancer screening, we found that patients in the MRI screening arm were less likely to be recommended to undergo prostate biopsy (relative risk 0.52, 95% CI 0.33 to 0.82). Despite a lower biopsy rate in the MRI group, there was a trend towards higher prostate cancer and clinically significant prostate cancer detection, although this did not reach statistical significance. Further, among the subgroup of patients in the MRI arm who had an end-of-study PSA test, recommendations based on a single screening PSA test would have both potentially missed patients with cancer and conversely, unnecessarily recommended prostate biopsy.

Strengths and weaknesses of the study

To our knowledge, this is the first randomised trial to directly compare serum PSA testing and prostate MRI for prostate cancer screening purposes. A major strength of our study is that each arm did not undergo the reciprocal test at the time of randomisation. More specifically, patients in the MRI arm did not have a PSA test at the time of randomisation. Thus, the potential bias introduced with a PSA test with the MRI could have led to violations in the study protocol with misleading results. The end-of-study PSA tests among patients in the MRI clearly showed how PSA levels could have affected biopsy and cancer detection rates.

Limitations of the current study include the conduct of the trial at a single centre and the higher drop-out rate seen in the PSA arm. Given the nature of the interventions, blinding was not possible. Biparametric MRI was used in this trial; however, bpMRI has been shown to have similar sensitivity and specificity compared with mpMRI and may be more cost-effective.[5 8] The Siemens Prisma

Table 2 Distribution of prostate biopsy grade by PSA and MRI arm

	PSA arm			MRI arm	
Histology grade	2.6–4.0	4.1–10.0	10.1–20.0	PIRADS 4	PIRADS 5
Gleason score 6		4		4	
Gleason score 7					
(3+4)	1		1	3	3
(4+3)	1			3	
Gleason score 8–10		1		2	

.PIRADS, Prostate Imaging-Reporting and Data System; PSA, prostate-specific antigen.

system 1 is one of the highest performance gradient systems for MRI. This can help improve the quality of DWI compared 3T gradient systems used in routine clinical practice. Given MRI interpretation was done by a single experienced reader on a high-performance system, our results may be optimistic if compared with multiplatform and reader performance.

Given that both systematic and targeted biopsy were used in combination in the MRI arm, this may introduce detection bias. Nevertheless, this represents the first randomised trial to compare PSA vs MRI for prostate cancer screening and confirms the utility and public acceptance of the use of MRI in this setting.

Given the occurrence of the COVID-19 pandemic during the trial, our study was terminated early and thus we were likely underpowered to show significance in our primary and secondary outcomes. The conduct of this trial during a global pandemic highlights an important consideration for future clinical trials. Consideration should be given to alternative means of study completion, for example, use of telephone or virtual assessment and the use of local labs and imaging centres when feasible. These strategies may not only enhance participant safety, but also facilitate easier completion of study assessments. In our study, access to prostate MRI and prostate biopsy were tied to our primary study site and required in person assessment. Other study designs and interventions may be more conducive to a hybrid in-person and remote assessment protocol.

Table 3 Distribution of end-of-study PSA and MRI PIRADS score among MRI arm

	PSA category (ng/mL)			
MRI PIRADS score	< 2.6	2.6–4.0	4.1–10.0	10.1–20.0
1–3	72 (86.8%)	12 (92.3%)	7 (36.8%)	2 (100%)
4–5	11 (13.2%)	1 (7.7%)	12 (63.2%)	0 (0%)

PIRADS, Prostate Imaging-Reporting and Data System; PSA, prostate-specific antigen.

Strengths and weaknesses in relation to other studies

PSA-based prostate cancer screening is limited by the lack of a concrete cut-off value and the poor specificity of the test. Although a serum PSA cut-off of 4.0 ng/mL has been suggested, as many as 25% of prostate cancers may present with a PSA less than this threshold. Indeed, in the MRI arm of the current trial, 18% of patients with diagnosed with clinically significant prostate cancer had a PSA <4.0 ng/mL. Thus, PSA-based prostate cancer screening lacks both sensitivity and specificity to identify men with aggressive prostate cancer. MRI offers several advantages including sparing biopsy in approximately one-third of patients, greater acceptance of the recommendation for prostate biopsy if the test is abnormal, much higher negative predictive value with targeted biopsy versus standard TRUS-guided biopsy, and the potential for this screening strategy to reduce the over diagnosis of clinically insignificant prostate cancer.

Eldred-Evans *et al* prospectively compared rates of cancer among 408 patients who had an ultrasound, MRI and PSA test in a blinded fashion—the IP1-PROSTAGRAM study.[9] If any one of the three tests was positive, the patient underwent systematic biopsy with ultrasound-MRI fusion biopsy as necessary. They showed a higher rate of clinically significant cancer with MRI using a PIRADS threshold of 4 or 5, compared with using a PSA threshold of >3.0 ng/mL for prostate biopsy. However, the blinding could have been revealed at the time prostate biopsy since MRI-based lesions would be revealed.

In our study, we estimate that the use of screening MRI for prostate cancer screening could reduce the need for prostate biopsy by approximately 48%. This is consistent with estimates from clinical trials examining prostate MRI among patients with abnormal PSA levels where 27% to 37% of patients could avoid prostate biopsy in the context of an elevated PSA test but negative MRI studies.[3 10 11] Recently, Eklund *et al* showed that MRI-based biopsy detected lower rates of insignificant cancer and higher rates of clinically significant cancer, but did not examine patients with PSA levels below 3.0 ng/mL.[12] Our study showed that among men randomised to the MRI arm, approximately 18% (2/11) of patients with clinically significant cancer had a normal PSA.

Meaning of the study

Other important observations from our study include the compliance rate of patients in the PSA arm. First, at the time of randomisation to PSA, 7% of patients dropped out of the study citing that they had wished to be randomised for an MRI. Second, when a biopsy was recommended by the PSA test, only about half of the patients agreed to undergo a biopsy, while 96% of patients agreed to undergo a biopsy in the MRI arm. Thus, the public perception of the effectiveness of PSA screening has waned. This perception may be warranted, given that there was a trend towards higher clinically significant cancer detection among patients in the MRI arm versus the PSA arm.

Unanswered questions and future research

While MRI has proven to be a useful clinical tool for prostate cancer risk stratification, the feasibility and cost-effectiveness of widespread population-based prostate MRI is a challenge in many clinical landscapes. A recent microsimulation model assessed the cost-effectiveness of PSA with MRI and MRI-guided biopsy for prostate cancer detection.[13] MRI-based prostate cancer screening resulted in more years of life gained and quality-adjusted life-years (QALY) by 3 and 3.5 years per 1000 men invited for screening, respectively. In the integrated cost-effectiveness analysis, MRI-based screening was associated with a cost of just over €11 000 per QALY gained compared with PSA-screening, suggesting MRI-based screening is cost-effective. In their analysis, compliance rates were assumed to be the same for both PSA-based and MRI-based screening. However, as demonstrated in this study, greater public acceptance of MRI-based screening may further increase the benefit of integrating MRI into prostate cancer screening practices. Indeed, imaging-based cancer screening approaches for breast (mammography), lung (low-dose CT) and colon (CT colonography) have been considered.

CONCLUSION

Stand-alone biparametric prostate MRI further reduces rates of unnecessary biopsy compared with PSA-based screening, while identifying patients with clinically significant forms of prostate cancer that would have been missed with serum PSA screening alone. More patients are willing to follow recommendations for prostate biopsy based on MRI results compared with PSA.

Twitter Amanda Hird @AHirdMD

Contributors RN, CW and MAH conceptualised and designed the study with input from CP, LM, UE and CS. PM and MS provided administrative support and collected all data. Interpretation of the results was completed by all coauthors. RN verified the underlying data. RN and AH contributed to writing the draft of the manuscript. All authors were involved with reviewing and editing the manuscript. All authors reviewed and approved of the final manuscript. All authors had full access to the data accept responsibility to submit for publication. The corresponding author and guarantor, RN attested that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval The study was approved by the Sunnybrook Research Ethics Board (REB#: 130-2016). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No data are available. Individual participant data that underlie the results reported in this article will not be shared. The study protocol will be made available online.

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Supplementary Appendix 1. Magnetic Resonance Imaging Parameters

MRI Parameters	
MRI manufacturer	Siemens
MRI Model	Prisma
Field Strength	3T
Coils	6 channel phased array
Sequences used	T2, DWI, DWIb1600
T2 sequence details	
Planes acquired	Axial, coronal, sagittal
Echo time (ms)	101
Number of Excitations	2
Reduction factor	2
Slice Thickness (axial) Voxel size (axial) (mm)	3x0.8x0.8
Typical scan time/sequence	166
DWI Sequence Details	
Plane acquired	axial
Pulse sequence	standard EPI
Echo time (ms)	57
B-values used (s/mm^2)	50,200,400,600,1000
Number of Excitations	1,2,3,3,8,12
ADC calculated b values	50,200,400,600,1000
Slice Thickness (axial) Voxel size (axial)	3x1.8x1.8
Typical scan time(s)	378
DWIb1600 Sequence Details	
Plane acquired	axial
Pulse sequence	segmented EPI (RESOLVE)
Echo time (ms)	55
B-values used (s/mm2)	0, 1600
Number of Excitations	1, 8
Reduction factor	2
ADC calculated b values	No
Slice Thickness (axial) Voxel size (axial)	3x1.6x1.6
Typical scan time(s)	404
Bowel Relaxant	No
Endorectal coil	No
Total Exam time (min)	30

SIEMENS MAGNETOM Prisma

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SIEMENS MAGNETOM Prisma

\\Research Funded\RESEARCH\MVPS1F -Study on HOLD\MVP_lastmod2017Jun28\Prostate-2D-initial-Scout

TA: 0:18 PM: REF Voxel size: 1.6×1.6×6.0 mmPAT: Off Rel. SNR: 1.00 : tfi

Properties

Prio recon	Off
Load images to viewer	Off
Inline movie	Off
Auto store images	On
Load images to stamp segments	Off
Load images to graphic segments	On
Auto open inline display	Off
Auto close inline display	Off
Start measurement without further preparation	On
Wait for user to start	Off
Start measurements	Single measurement

Routine

Slice group	1
Slices	7
Dist. factor	50 %
Position	L0.0 P30.0 H0.0 mm
Orientation	Sagittal
Phase enc. dir.	A >> P
Slice group	2
Slices	5
Dist. factor	50 %
Position	L16.0 P40.7 H0.0 mm
Orientation	Transversal
Phase enc. dir.	A >> P
Slice group	3
Slices	5
Dist. factor	50 %
Position	L16.0 P40.7 H0.0 mm
Orientation	Coronal
Phase enc. dir.	R >> L
AutoAlign	---
Phase oversampling	30 %
FoV read	300 mm
FoV phase	100.0 %
Slice thickness	6.0 mm
TR	3.45 ms
TE	1.53 ms
Averages	1
Filter	Distortion Corr.(2D)
Coil elements	BO1-3;SP1-8

Contrast - Common

TR	3.45 ms
TE	1.53 ms
TD	0 ms
Magn. preparation	None
Flip angle	49 deg
Fat suppr.	Fat sat.

Contrast - Dynamic

Averages	1
Averaging mode	Short term
Reconstruction	Magnitude
Measurements	1
Multiple series	Each measurement

Resolution - Common

FoV read	300 mm
FoV phase	100.0 %
Slice thickness	6.0 mm
Base resolution	192
Phase resolution	100 %
Phase partial Fourier	Off
Interpolation	Off

Resolution - iPAT

PAT mode	None

Resolution - Filter Image

Image Filter	Off
Distortion Corr.	On
Mode	2D
Unfiltered images	Off
Prescan Normalize	Off
Normalize	Off
B1 filter	Off

Resolution - Filter Rawdata

Raw filter	Off
Elliptical filter	Off

Geometry - Common

Slice group	1
Slices	7
Dist. factor	50 %
Position	L0.0 P30.0 H0.0 mm
Orientation	Sagittal
Phase enc. dir.	A >> P
Slice group	2
Slices	5
Dist. factor	50 %
Position	L16.0 P40.7 H0.0 mm
Orientation	Transversal
Phase enc. dir.	A >> P
Slice group	3
Slices	5
Dist. factor	50 %
Position	L16.0 P40.7 H0.0 mm
Orientation	Coronal
Phase enc. dir.	R >> L
FoV read	300 mm
FoV phase	100.0 %
Slice thickness	6.0 mm
TR	3.45 ms
Multi-slice mode	Sequential
Series	Ascending

Geometry - AutoAlign

Slice group	1
Position	L0.0 P30.0 H0.0 mm
Orientation	Sagittal
Phase enc. dir.	A >> P
Slice group	2
Position	L16.0 P40.7 H0.0 mm
Orientation	Transversal
Phase enc. dir.	A >> P

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Geometry - AutoAlign

Slice group	3
Position	L16.0 P40.7 H0.0 mm
Orientation	Coronal
Phase enc. dir.	R >> L
AutoAlign	---
Initial Position	Isocenter
L	0.0 mm
P	0.0 mm
H	0.0 mm
Initial Rotation	0.00 deg
Initial Orientation	Transversal

Geometry - Navigator

Geometry - Tim Planning Suite

Set-n-Go Protocol	Off
Table position	H
Table position	0 mm
Inline Composing	Off

System - Miscellaneous

Positioning mode	REF
Table position	H
Table position	0 mm
MSMA	S - C - T
Sagittal	R >> L
Coronal	A >> P
Transversal	H >> F
Coil Combine Mode	Adaptive Combine
Save uncombined	Off
Matrix Optimization	Off
Coil Focus	Flat
AutoAlign	---
Coil Select Mode	Default

System - Adjustments

B0 Shim mode	Tune up
B1 Shim mode	TrueForm
Adjust with body coil	Off
Confirm freq. adjustment	Off
Assume Dominant Fat	Off
Assume Silicone	Off
Adjustment Tolerance	Auto

System - Adjust Volume

Position	Isocenter
Orientation	Transversal
Rotation	0.00 deg
A >> P	263 mm
R >> L	350 mm
F >> H	350 mm
Reset	Off

System - pTx Volumes

B1 Shim mode	TrueForm
Excitation	Slice-sel.

System - Tx/Rx

Frequency 1H	123.250212 MHz
Correction factor	1
Gain	High
Img. Scale Cor.	1.000
Reset	Off

System - Tx/Rx

? Ref. amplitude 1H	0.000 V

Physio - Signal1

1st Signal/Mode	None
TR	3.45 ms
Segments	1

Physio - PACE

Resp. control	Off

Inline - Common

Subtract	Off
Measurements	1
StdDev	Off
Save original images	On

Inline - MIP

MIP-Sag	Off
MIP-Cor	Off
MIP-Tra	Off
MIP-Time	Off
Save original images	On

Inline - Composing

Inline Composing	Off
Distortion Corr.	On
Mode	2D
Unfiltered images	Off

Sequence - Part 1

Introduction	On
Dimension	2D
Reordering	Centric
Asymmetric echo	Allowed
Flow comp.	No
Multi-slice mode	Sequential
Bandwidth	1002 Hz/Px

Sequence - Part 2

Segments	1
RF pulse type	Normal
Gradient mode	Normal
Excitation	Slice-sel.

Sequence - Assistant

Mode	Off

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\\Research Funded\RESEARCH\MVPS1F -Study on HOLD\MVP_lastmod2017Jun28\Localiser@Center
TA: 0:13 PM: ISO Voxel size: 2.0×2.0×6.0 mmPAT: Off Rel. SNR: 1.00 : tfi

Properties

Prio recon	Off
Load images to viewer	On
Inline movie	Off
Auto store images	On
Load images to stamp segments	On
Load images to graphic segments	On
Auto open inline display	Off
Auto close inline display	Off
Start measurement without further preparation	Off
Wait for user to start	Off
Start measurements	Single measurement

Routine

Slice group	1
Slices	3
Dist. factor	50 %
Position	L25.4 A8.5 H10.9 mm
Orientation	Sagittal
Phase enc. dir.	A >> P
Slice group	2
Slices	5
Dist. factor	50 %
Position	L21.1 A30.3 H25.4 mm
Orientation	Transversal
Phase enc. dir.	A >> P
Slice group	3
Slices	5
Dist. factor	50 %
Position	L21.1 A6.3 H26.2 mm
Orientation	Coronal
Phase enc. dir.	R >> L
AutoAlign	---
Phase oversampling	30 %
FoV read	380 mm
FoV phase	100.0 %
Slice thickness	6.0 mm
TR	3.24 ms
TE	1.44 ms
Averages	1
Filter	Distortion Corr.(2D), Prescan Normalize
Coil elements	BO1-3;SP3-6

Contrast - Common

TR	3.24 ms
TE	1.44 ms
TD	0 ms
Magn. preparation	None
Flip angle	49 deg
Fat suppr.	Fat sat.

Contrast - Dynamic

Averages	1
Averaging mode	Short term
Reconstruction	Magnitude
Measurements	1
Multiple series	Each measurement

Resolution - Common

FoV read	380 mm
FoV phase	100.0 %
Slice thickness	6.0 mm
Base resolution	192
Phase resolution	100 %
Phase partial Fourier	Off
Interpolation	Off

Resolution - iPAT

PAT mode	None

Resolution - Filter Image

Image Filter	Off
Distortion Corr.	On
Mode	2D
Unfiltered images	Off
Prescan Normalize	On
Unfiltered images	Off
Normalize	Off
B1 filter	Off

Resolution - Filter Rawdata

Raw filter	Off
Elliptical filter	Off

Geometry - Common

Slice group	1
Slices	3
Dist. factor	50 %
Position	L25.4 A8.5 H10.9 mm
Orientation	Sagittal
Phase enc. dir.	A >> P
Slice group	2
Slices	5
Dist. factor	50 %
Position	L21.1 A30.3 H25.4 mm
Orientation	Transversal
Phase enc. dir.	A >> P
Slice group	3
Slices	5
Dist. factor	50 %
Position	L21.1 A6.3 H26.2 mm
Orientation	Coronal
Phase enc. dir.	R >> L
FoV read	380 mm
FoV phase	100.0 %
Slice thickness	6.0 mm
TR	3.24 ms
Multi-slice mode	Sequential
Series	Ascending

Geometry - AutoAlign

Slice group	1
Position	L25.4 A8.5 H10.9 mm
Orientation	Sagittal
Phase enc. dir.	A >> P
Slice group	2
Position	L21.1 A30.3 H25.4 mm
Orientation	Transversal

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Geometry - AutoAlign

Phase enc. dir.	A >> P
Slice group	3
Position	L21.1 A6.3 H26.2 mm
Orientation	Coronal
Phase enc. dir.	R >> L
AutoAlign	---
Initial Position	L25.4 A8.5 H10.9
L	25.4 mm
A	8.5 mm
H	10.9 mm
Initial Rotation	0.00 deg
Initial Orientation	Sagittal

Geometry - Navigator

Geometry - Tim Planning Suite

Set-n-Go Protocol	Off
Table position	H
Table position	19 mm
Inline Composing	Off

System - Miscellaneous

Positioning mode	ISO
Table position	H
Table position	19 mm
MSMA	S - C - T
Sagittal	R >> L
Coronal	A >> P
Transversal	H >> F
Coil Combine Mode	Adaptive Combine
Save uncombined	Off
Matrix Optimization	Off
Coil Focus	Flat
AutoAlign	---
Coil Select Mode	On - AutoCoilSelect

System - Adjustments

B0 Shim mode	Tune up
B1 Shim mode	TrueForm
Adjust with body coil	Off
Confirm freq. adjustment	Off
Assume Dominant Fat	Off
Assume Silicone	Off
Adjustment Tolerance	Auto

System - Adjust Volume

Position	Isocenter
Orientation	Transversal
Rotation	0.00 deg
A >> P	263 mm
R >> L	350 mm
F >> H	350 mm
Reset	Off

System - pTx Volumes

B1 Shim mode	TrueForm
Excitation	Slice-sel.

System - Tx/Rx

Frequency 1H	123.250212 MHz
Correction factor	1
Gain	High
Img. Scale Cor.	1.000

System - Tx/Rx

Reset	Off
? Ref. amplitude 1H	0.000 V

Physio - Signal1

1st Signal/Mode	None
TR	3.24 ms
Segments	1

Physio - PACE

Resp. control	Off

Inline - Common

Subtract	Off
Measurements	1
StdDev	Off
Save original images	On

Inline - MIP

MIP-Sag	Off
MIP-Cor	Off
MIP-Tra	Off
MIP-Time	Off
Save original images	On

Inline - Composing

Inline Composing	Off
Distortion Corr.	On
Mode	2D
Unfiltered images	Off

Sequence - Part 1

Introduction	On
Dimension	2D
Reordering	Centric
Asymmetric echo	Allowed
Flow comp.	No
Multi-slice mode	Sequential
Bandwidth	1002 Hz/Px

Sequence - Part 2

Segments	1
RF pulse type	Normal
Gradient mode	Normal
Excitation	Slice-sel.

Sequence - Assistant

Mode	Off

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\\Research Funded\RESEARCH\MVPS1F -Study on HOLD\MVP_lastmod2017Jun28\T2_TSE_sag

TA: 2:47 PM: ISO Voxel size: 0.6×0.6×3.0 mmPAT: 2 Rel. SNR: 1.00 : tse

Properties

Prio recon	Off
Load images to viewer	On
Inline movie	Off
Auto store images	On
Load images to stamp segments	On
Load images to graphic segments	On
Auto open inline display	Off
Auto close inline display	Off
Start measurement without further preparation	Off
Wait for user to start	Off
Start measurements	Single measurement

Routine

Slice group	1
Slices	25
Dist. factor	0 %
Position	L22.7 P3.6 H35.1 mm
Orientation	Sagittal
Phase enc. dir.	H >> F
AutoAlign	---
Phase oversampling	100 %
FoV read	200 mm
FoV phase	100.0 %
Slice thickness	3.0 mm
TR	7200.0 ms
TE	101 ms
Averages	2
Concatenations	1
Filter	Distortion Corr.(2D), Prescan Normalize
Coil elements	BO1-3;SP4,5

Contrast - Common

TR	7200.0 ms
TE	101 ms
MTC	Off
Magn. preparation	None
Flip angle	160 deg
Fat suppr.	None
Water suppr.	None
Restore magn.	Off

Contrast - Dynamic

Averages	2
Averaging mode	Long term
Reconstruction	Magnitude
Measurements	1
Multiple series	Each measurement

Resolution - Common

FoV read	200 mm
FoV phase	100.0 %
Slice thickness	3.0 mm
Base resolution	320
Phase resolution	80 %
Phase partial Fourier	Off
Trajectory	Cartesian
Interpolation	Off

Resolution - iPAT

PAT mode	GRAPPA
Accel. factor PE	2
Ref. lines PE	32
Reference scan mode	Self-calibration

Resolution - Filter Image

Image Filter	Off
Distortion Corr.	On
Mode	2D
Unfiltered images	Off
Prescan Normalize	On
Unfiltered images	Off
Normalize	Off
B1 filter	Off

Resolution - Filter Rawdata

Raw filter	Off
Elliptical filter	Off

Geometry - Common

Slice group	1
Slices	25
Dist. factor	0 %
Position	L22.7 P3.6 H35.1 mm
Orientation	Sagittal
Phase enc. dir.	H >> F
FoV read	200 mm
FoV phase	100.0 %
Slice thickness	3.0 mm
TR	7200.0 ms
Multi-slice mode	Interleaved
Series	Interleaved
Concatenations	1

Geometry - AutoAlign

Slice group	1
Position	L22.7 P3.6 H35.1 mm
Orientation	Sagittal
Phase enc. dir.	H >> F
AutoAlign	---
Initial Position	L22.7 P3.6 H35.1
L	22.7 mm
P	3.6 mm
H	35.1 mm
Initial Rotation	90.00 deg
Initial Orientation	Sagittal

Geometry - Saturation

Fat suppr.	None
Water suppr.	None
Restore magn.	Off
Special sat.	None

Geometry - Navigator

Geometry - Tim Planning Suite

Set-n-Go Protocol	Off
Table position	H
Table position	35 mm
Inline Composing	Off

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System - Miscellaneous

Positioning mode	ISO
Table position	H
Table position	35 mm
MSMA	S - C - T
Sagittal	R >> L
Coronal	A >> P
Transversal	H >> F
Coil Combine Mode	Adaptive Combine
Save uncombined	Off
Matrix Optimization	Off
Coil Focus	Flat
AutoAlign	---
Coil Select Mode	On - AutoCoilSelect

System - Adjustments

B0 Shim mode	Tune up
B1 Shim mode	TrueForm
Adjust with body coil	Off
Confirm freq. adjustment	Off
Assume Dominant Fat	Off
Assume Silicone	Off
Adjustment Tolerance	Auto

System - Adjust Volume

Position	Isocenter
Orientation	Transversal
Rotation	0.00 deg
A >> P	263 mm
R >> L	350 mm
F >> H	350 mm
Reset	Off

System - pTx Volumes

B1 Shim mode	TrueForm

System - Tx/Rx

Frequency 1H	123.250212 MHz
Correction factor	1
Gain	High
Img. Scale Cor.	1.000
Reset	Off
? Ref. amplitude 1H	0.000 V

Physio - Signal1

1st Signal/Mode	None
TR	7200.0 ms
Concatenations	1

Physio - Cardiac

Magn. preparation	None
Fat suppr.	None
Dark blood	Off
FoV read	200 mm
FoV phase	100.0 %
Phase resolution	80 %
Trajectory	Cartesian

Physio - PACE

Resp. control	Off
Concatenations	1

Inline - Common

Subtract	Off

Inline - Common

Measurements	1
StdDev	Off
Save original images	On

Inline - MIP

MIP-Sag	Off
MIP-Cor	Off
MIP-Tra	Off
MIP-Time	Off
Save original images	On

Inline - Composing

Inline Composing	Off
Distortion Corr.	On
Mode	2D
Unfiltered images	Off

Sequence - Part 1

Introduction	On
Dimension	2D
Compensate T2 decay	Off
Reduce Motion Sens.	On
Contrasts	1
Flow comp.	No
Multi-slice mode	Interleaved
Free echo spacing	Off
Echo spacing	11.2 ms
Bandwidth	200 Hz/Px

Sequence - Part 2

Define	Turbo factor
Echo trains per slice	11
Phase correction	Automatic
Acoustic noise reduction	None
RF pulse type	Low SAR
Gradient mode	Normal
Hyperecho	Off
WARP	Off
Red. EC sensitivity	Off
Turbo factor	25

Sequence - Assistant

Mode	Min flip angle
Min flip angle	150 deg
Allowed delay	30 s

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TA: 6:18 PM: ISO Voxel size: 1.8×1.8×3.0 mmPAT: Off Rel. SNR: 1.00 : epse

Properties

Prio recon	Off
Load images to viewer	On
Inline movie	Off
Auto store images	On
Load images to stamp segments	On
Load images to graphic segments	Off
Auto open inline display	Off
Auto close inline display	Off
Start measurement without further preparation	Off
Wait for user to start	Off
Start measurements	Single measurement

Routine

Slice group	1
Slices	24
Dist. factor	0 %
Position	L20.4 P0.7 H23.7 mm
Orientation	Transversal
Phase enc. dir.	A >> P
AutoAlign	---
Phase oversampling	0 %
FoV read	200 mm
FoV phase	100.0 %
Slice thickness	3.0 mm
TR	4400 ms
TE	57.0 ms
Concatenations	1
Filter	Distortion Corr.(2D)
Coil elements	BO2;SP4,5

Contrast - Common

TR	4400 ms
TE	57.0 ms
MTC	Off
Magn. preparation	None
Fat suppr.	SPAIR
Fat sat. mode	Strong

Contrast - Dynamic

Averaging mode	Long term
Reconstruction	Magnitude
Measurements	1
Delay in TR	0 ms

Resolution - Common

FoV read	200 mm
FoV phase	100.0 %
Slice thickness	3.0 mm
Base resolution	110
Phase resolution	100 %
Phase partial Fourier	6/8
Interpolation	Off

Resolution - iPAT

Accel. mode	None

Resolution - Filter Image

Distortion Corr.	On

Resolution - Filter Image

Mode	2D
Prescan Normalize	Off
Dynamic Field Corr.	Off

Resolution - Filter Rawdata

Raw filter	Off
Elliptical filter	Off

Geometry - Common

Slice group	1
Slices	24
Dist. factor	0 %
Position	L20.4 P0.7 H23.7 mm
Orientation	Transversal
Phase enc. dir.	A >> P
FoV read	200 mm
FoV phase	100.0 %
Slice thickness	3.0 mm
TR	4400 ms
Multi-slice mode	Interleaved
Series	Descending
Concatenations	1

Geometry - AutoAlign

Slice group	1
Position	L20.4 P0.7 H23.7 mm
Orientation	Transversal
Phase enc. dir.	A >> P
AutoAlign	---
Initial Position	L20.4 P0.7 H23.7
L	20.4 mm
P	0.7 mm
H	23.7 mm
Initial Rotation	0.00 deg
Initial Orientation	Transversal

Geometry - Saturation

Sat. region	1
Thickness	60 mm
Position	L0.0 A100.0 H19.0 mm
Orientation	Coronal
Sat. region	2
Thickness	60 mm
Position	L0.0 P100.0 H19.0 mm
Orientation	Coronal
Fat sat. mode	Strong
Special sat.	None

Geometry - Navigator

Geometry - Tim Planning Suite

Set-n-Go Protocol	Off
Table position	H
Table position	24 mm
Inline Composing	Off

System - Miscellaneous

Positioning mode	ISO

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System - Miscellaneous

Table position	H
Table position	24 mm
MSMA	S - C - T
Sagittal	R >> L
Coronal	A >> P
Transversal	H >> F
Coil Combine Mode	Adaptive Combine
Matrix Optimization	Performance
Coil Focus	Flat
AutoAlign	---
Coil Select Mode	Default

System - Adjustments

B0 Shim mode	Standard
B1 Shim mode	TrueForm
Adjust with body coil	Off
Confirm freq. adjustment	Off
Assume Dominant Fat	Off
Assume Silicone	Off
Adjustment Tolerance	Auto

System - Adjust Volume

Position	L20.4 P0.7 H23.7 mm
Orientation	Transversal
Rotation	0.00 deg
A >> P	200 mm
R >> L	200 mm
F >> H	72 mm
Reset	Off

System - pTx Volumes

B1 Shim mode	TrueForm
Excitation	Standard

System - Tx/Rx

Frequency 1H	123.250212 MHz
Correction factor	1
Gain	High
Img. Scale Cor.	2.000
Reset	Off
? Ref. amplitude 1H	0.000 V

Physio - Signal1

1st Signal/Mode	None
TR	4400 ms
Concatenations	1

Physio - PACE

Resp. control	Off
Concatenations	1

Diff - Neuro

Diffusion mode	3-Scan Trace
Diff. directions	3
Diffusion Scheme	Monopolar
Diff. weightings	6
b-value 1	0 s/mm²
b-value 2	100 s/mm²
b-value 3	200 s/mm²
b-value 4	400 s/mm²
b-value 5	600 s/mm²
b-value 6	1000 s/mm²
b-value 1	1

Diff - Neuro

b-value 2	2
b-value 3	3
b-value 4	3
b-value 5	8
b-value 6	12
Diff. weighted images	Off
Trace weighted images	On
ADC maps	On
FA maps	Off
Mosaic	Off
Tensor	Off
Noise level	0

Diff - Body

Diffusion mode	3-Scan Trace
Diff. directions	3
Diffusion Scheme	Monopolar
Diff. weightings	6
b-value 1	0 s/mm²
b-value 2	100 s/mm²
b-value 3	200 s/mm²
b-value 4	400 s/mm²
b-value 5	600 s/mm²
b-value 6	1000 s/mm²
b-value 1	1
b-value 2	2
b-value 3	3
b-value 4	3
b-value 5	8
b-value 6	12
Diff. weighted images	Off
Trace weighted images	On
ADC maps	On
Exponential ADC Maps	Off
FA maps	Off
Invert Gray Scale	Off
Calculated Image	Off
b-Value >=	0 s/mm²
Noise level	0

Diff - Composing

Inline Composing	Off
Distortion Corr.	On
Mode	2D

Sequence - Part 1

Introduction	Off
Optimization	Min. TE
Multi-slice mode	Interleaved
Free echo spacing	Off
Echo spacing	0.59 ms
Bandwidth	1894 Hz/Px

Sequence - Part 2

EPI factor	110
RF pulse type	Normal
Gradient mode	Performance
Excitation	Standard

Sequence - pTX Pulses

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\\Research Funded\RESEARCH\MVPS1F -Study on HOLD\MVP_lastmod2017Jun28\T2_TSE_tra

TA: 2:19 PM: ISO Voxel size: 0.7×0.7×3.0 mmPAT: 2 Rel. SNR: 1.00 : tse

Properties

Prio recon	Off
Load images to viewer	On
Inline movie	Off
Auto store images	On
Load images to stamp segments	On
Load images to graphic segments	On
Auto open inline display	Off
Auto close inline display	Off
Start measurement without further preparation	Off
Wait for user to start	Off
Start measurements	Single measurement

Routine

Slice group	1
Slices	28
Dist. factor	0 %
Position	L20.4 P0.7 H23.7 mm
Orientation	Transversal
Phase enc. dir.	R >> L
AutoAlign	---
Phase oversampling	80 %
FoV read	180 mm
FoV phase	100.0 %
Slice thickness	3.0 mm
TR	8060.0 ms
TE	97 ms
Averages	2
Concatenations	1
Filter	Distortion Corr.(2D), Normalize
Coil elements	BO2;SP4,5

Contrast - Common

TR	8060.0 ms
TE	97 ms
MTC	Off
Magn. preparation	None
Flip angle	160 deg
Fat suppr.	None
Water suppr.	None
Restore magn.	Off

Contrast - Dynamic

Averages	2
Averaging mode	Long term
Reconstruction	Magnitude
Measurements	1
Multiple series	Each measurement

Resolution - Common

FoV read	180 mm
FoV phase	100.0 %
Slice thickness	3.0 mm
Base resolution	256
Phase resolution	80 %
Phase partial Fourier	Off
Trajectory	Cartesian
Interpolation	Off

Resolution - iPAT

PAT mode	GRAPPA
Accel. factor PE	2
Ref. lines PE	32
Reference scan mode	Self-calibration

Resolution - Filter Image

Image Filter	Off
Distortion Corr.	On
Mode	2D
Unfiltered images	Off
Prescan Normalize	Off
Normalize	On
B1 filter	Off

Resolution - Filter Rawdata

Raw filter	Off
Elliptical filter	Off

Geometry - Common

Slice group	1
Slices	28
Dist. factor	0 %
Position	L20.4 P0.7 H23.7 mm
Orientation	Transversal
Phase enc. dir.	R >> L
FoV read	180 mm
FoV phase	100.0 %
Slice thickness	3.0 mm
TR	8060.0 ms
Multi-slice mode	Interleaved
Series	Interleaved
Concatenations	1

Geometry - AutoAlign

Slice group	1
Position	L20.4 P0.7 H23.7 mm
Orientation	Transversal
Phase enc. dir.	R >> L
AutoAlign	---
Initial Position	L20.4 P0.7 H23.7
L	20.4 mm
P	0.7 mm
H	23.7 mm
Initial Rotation	90.00 deg
Initial Orientation	Transversal

Geometry - Saturation

Fat suppr.	None
Water suppr.	None
Restore magn.	Off
Special sat.	None

Geometry - Navigator

Geometry - Tim Planning Suite

Set-n-Go Protocol	Off
Table position	H
Table position	24 mm
Inline Composing	Off

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System - Miscellaneous

Positioning mode	ISO
Table position	H
Table position	24 mm
MSMA	S - C - T
Sagittal	R >> L
Coronal	A >> P
Transversal	H >> F
Coil Combine Mode	Adaptive Combine
Save uncombined	Off
Matrix Optimization	Off
Coil Focus	Flat
AutoAlign	---
Coil Select Mode	On - AutoCoilSelect

System - Adjustments

B0 Shim mode	Tune up
B1 Shim mode	TrueForm
Adjust with body coil	Off
Confirm freq. adjustment	Off
Assume Dominant Fat	Off
Assume Silicone	Off
Adjustment Tolerance	Auto

System - Adjust Volume

Position	Isocenter
Orientation	Transversal
Rotation	0.00 deg
A >> P	263 mm
R >> L	350 mm
F >> H	350 mm
Reset	Off

System - pTx Volumes

B1 Shim mode	TrueForm

System - Tx/Rx

Frequency 1H	123.250212 MHz
Correction factor	1
Gain	High
Img. Scale Cor.	1.000
Reset	Off
? Ref. amplitude 1H	0.000 V

Physio - Signal1

1st Signal/Mode	None
TR	8060.0 ms
Concatenations	1

Physio - Cardiac

Magn. preparation	None
Fat suppr.	None
Dark blood	Off
FoV read	180 mm
FoV phase	100.0 %
Phase resolution	80 %
Trajectory	Cartesian

Physio - PACE

Resp. control	Off
Concatenations	1

Inline - Common

Subtract	Off

Inline - Common

Measurements	1
StdDev	Off
Save original images	On

Inline - MIP

MIP-Sag	Off
MIP-Cor	Off
MIP-Tra	Off
MIP-Time	Off
Save original images	On

Inline - Composing

Inline Composing	Off
Distortion Corr.	On
Mode	2D
Unfiltered images	Off

Sequence - Part 1

Introduction	On
Dimension	2D
Compensate T2 decay	Off
Reduce Motion Sens.	On
Contrasts	1
Flow comp.	No
Multi-slice mode	Interleaved
Free echo spacing	Off
Echo spacing	10.8 ms
Bandwidth	199 Hz/Px

Sequence - Part 2

Define	Turbo factor
Echo trains per slice	8
Phase correction	Automatic
Acoustic noise reduction	None
RF pulse type	Low SAR
Gradient mode	Normal
Hyperecho	Off
WARP	Off
Red. EC sensitivity	Off
Turbo factor	25

Sequence - Assistant

Mode	Min flip angle
Min flip angle	150 deg
Allowed delay	30 s

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\\Research Funded\RESEARCH\MVPS1F -Study on HOLD\MVP_lastmod2017Jun28\T2_TSE_cor

TA: 2:27 PM: ISO Voxel size: 0.6×0.6×3.0 mmPAT: 2 Rel. SNR: 1.00 : tse

Properties

Prio recon	Off
Load images to viewer	On
Inline movie	Off
Auto store images	On
Load images to stamp segments	On
Load images to graphic segments	On
Auto open inline display	Off
Auto close inline display	Off
Start measurement without further preparation	Off
Wait for user to start	Off
Start measurements	Single measurement

Routine

Slice group	1
Slices	24
Dist. factor	0 %
Position	L22.7 P3.6 H35.1 mm
Orientation	Coronal
Phase enc. dir.	R >> L
AutoAlign	---
Phase oversampling	80 %
FoV read	200 mm
FoV phase	100.0 %
Slice thickness	3.0 mm
TR	6910.0 ms
TE	101 ms
Averages	2
Concatenations	1
Filter	Distortion Corr.(2D), Prescan Normalize
Coil elements	BO1-3;SP4,5

Contrast - Common

TR	6910.0 ms
TE	101 ms
MTC	Off
Magn. preparation	None
Flip angle	160 deg
Fat suppr.	None
Water suppr.	None
Restore magn.	Off

Contrast - Dynamic

Averages	2
Averaging mode	Long term
Reconstruction	Magnitude
Measurements	1
Multiple series	Each measurement

Resolution - Common

FoV read	200 mm
FoV phase	100.0 %
Slice thickness	3.0 mm
Base resolution	320
Phase resolution	80 %
Phase partial Fourier	Off
Trajectory	Cartesian
Interpolation	Off

Resolution - iPAT

PAT mode	GRAPPA
Accel. factor PE	2
Ref. lines PE	32
Reference scan mode	Self-calibration

Resolution - Filter Image

Image Filter	Off
Distortion Corr.	On
Mode	2D
Unfiltered images	Off
Prescan Normalize	On
Unfiltered images	Off
Normalize	Off
B1 filter	Off

Resolution - Filter Rawdata

Raw filter	Off
Elliptical filter	Off

Geometry - Common

Slice group	1
Slices	24
Dist. factor	0 %
Position	L22.7 P3.6 H35.1 mm
Orientation	Coronal
Phase enc. dir.	R >> L
FoV read	200 mm
FoV phase	100.0 %
Slice thickness	3.0 mm
TR	6910.0 ms
Multi-slice mode	Interleaved
Series	Interleaved
Concatenations	1

Geometry - AutoAlign

Slice group	1
Position	L22.7 P3.6 H35.1 mm
Orientation	Coronal
Phase enc. dir.	R >> L
AutoAlign	---
Initial Position	L22.7 P3.6 H35.1
L	22.7 mm
P	3.6 mm
H	35.1 mm
Initial Rotation	0.00 deg
Initial Orientation	Coronal

Geometry - Saturation

Fat suppr.	None
Water suppr.	None
Restore magn.	Off
Special sat.	None

Geometry - Navigator

Geometry - Tim Planning Suite

Set-n-Go Protocol	Off
Table position	H
Table position	35 mm
Inline Composing	Off

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System - Miscellaneous

Positioning mode	ISO
Table position	H
Table position	35 mm
MSMA	S - C - T
Sagittal	R >> L
Coronal	A >> P
Transversal	H >> F
Coil Combine Mode	Adaptive Combine
Save uncombined	Off
Matrix Optimization	Off
Coil Focus	Flat
AutoAlign	---
Coil Select Mode	On - AutoCoilSelect

System - Adjustments

B0 Shim mode	Tune up
B1 Shim mode	TrueForm
Adjust with body coil	Off
Confirm freq. adjustment	Off
Assume Dominant Fat	Off
Assume Silicone	Off
Adjustment Tolerance	Auto

System - Adjust Volume

Position	Isocenter
Orientation	Transversal
Rotation	0.00 deg
A >> P	263 mm
R >> L	350 mm
F >> H	350 mm
Reset	Off

System - pTx Volumes

B1 Shim mode	TrueForm

System - Tx/Rx

Frequency 1H	123.250212 MHz
Correction factor	1
Gain	High
Img. Scale Cor.	1.000
Reset	Off
? Ref. amplitude 1H	0.000 V

Physio - Signal1

1st Signal/Mode	None
TR	6910.0 ms
Concatenations	1

Physio - Cardiac

Magn. preparation	None
Fat suppr.	None
Dark blood	Off
FoV read	200 mm
FoV phase	100.0 %
Phase resolution	80 %
Trajectory	Cartesian

Physio - PACE

Resp. control	Off
Concatenations	1

Inline - Common

Subtract	Off

Inline - Common

Measurements	1
StdDev	Off
Save original images	On

Inline - MIP

MIP-Sag	Off
MIP-Cor	Off
MIP-Tra	Off
MIP-Time	Off
Save original images	On

Inline - Composing

Inline Composing	Off
Distortion Corr.	On
Mode	2D
Unfiltered images	Off

Sequence - Part 1

Introduction	On
Dimension	2D
Compensate T2 decay	Off
Reduce Motion Sens.	On
Contrasts	1
Flow comp.	No
Multi-slice mode	Interleaved
Free echo spacing	Off
Echo spacing	11.2 ms
Bandwidth	200 Hz/Px

Sequence - Part 2

Define	Turbo factor
Echo trains per slice	10
Phase correction	Automatic
Acoustic noise reduction	None
RF pulse type	Low SAR
Gradient mode	Normal
Hyperecho	Off
WARP	Off
Red. EC sensitivity	Off
Turbo factor	25

Sequence - Assistant

Mode	Min flip angle
Min flip angle	150 deg
Allowed delay	30 s

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\\Research Funded\RESEARCH\MVPS1F -Study on HOLD\MVP_lastmod2017Jun28\T1_VIBE_tra

TA: 0:14 PM: ISO Voxel size: 1.0×1.0×3.2 mmPAT: 2 Rel. SNR: 1.00 : fl

Properties

Prio recon	Off
Load images to viewer	On
Inline movie	Off
Auto store images	On
Load images to stamp segments	On
Load images to graphic segments	Off
Auto open inline display	Off
Auto close inline display	Off
Start measurement without further preparation	Off
Wait for user to start	Off
Start measurements	Single measurement

Routine

Slab group	1
Slabs	1
Dist. factor	20 %
Position	L20.4 P0.7 H23.7 mm
Orientation	Transversal
Phase enc. dir.	A >> P
AutoAlign	---
Phase oversampling	50 %
Slice oversampling	25.0 %
Slices per slab	32
FoV read	200 mm
FoV phase	100.0 %
Slice thickness	3.2 mm
TR	4.59 ms
TE	1.68 ms
Averages	1
Concatenations	1
Filter	Distortion Corr.(2D)
Coil elements	BO2;SP4,5

Contrast - Common

TR	4.59 ms
TE	1.68 ms
Flip angle	15.0 deg
Fat suppr.	Q-fat sat.
Lines Per Shot	40
Water suppr.	None
Dixon	Off

Contrast - Dynamic

Averages	1
Averaging mode	Short term
Reconstruction	Magnitude
Measurements	1
Multiple series	Each measurement

Resolution - Common

FoV read	200 mm
FoV phase	100.0 %
Slice thickness	3.2 mm
Base resolution	192
Phase resolution	72 %
Slice resolution	65 %
Phase partial Fourier	Off
Slice partial Fourier	Off
Trajectory	Cartesian

Resolution - Common

View sharing	Off
Interpolation	Off

Resolution - iPAT

PAT mode	GRAPPA
Accel. factor PE	2
Ref. lines PE	24
Accel. factor 3D	1
Reference scan mode	Integrated

Resolution - Filter Image

Image Filter	Off
Distortion Corr.	On
Mode	2D
Unfiltered images	Off
Prescan Normalize	Off
Normalize	Off
B1 filter	Off

Resolution - Filter Rawdata

Raw filter	Off
Elliptical filter	Off
POCS	Off

Geometry - Common

Slab group	1
Slabs	1
Dist. factor	20 %
Position	L20.4 P0.7 H23.7 mm
Orientation	Transversal
Phase enc. dir.	A >> P
Slice oversampling	25.0 %
Slices per slab	32
FoV read	200 mm
FoV phase	100.0 %
Slice thickness	3.2 mm
TR	4.59 ms
Multi-slice mode	Sequential
Series	Ascending
Concatenations	1

Geometry - AutoAlign

Slab group	1
Position	L20.4 P0.7 H23.7 mm
Orientation	Transversal
Phase enc. dir.	A >> P
AutoAlign	---
Initial Position	L20.4 P0.7 H23.7
L	20.4 mm
P	0.7 mm
H	23.7 mm
Initial Rotation	0.00 deg
Initial Orientation	Transversal

Geometry - Saturation

Fat suppr.	Q-fat sat.
Water suppr.	None
Dixon	Off
Special sat.	None

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Geometry - Tim Planning Suite

Set-n-Go Protocol	Off
Table position	H
Table position	24 mm
Inline Composing	Off

System - Miscellaneous

Positioning mode	ISO
Table position	H
Table position	24 mm
MSMA	S - C - T
Sagittal	R >> L
Coronal	A >> P
Transversal	H >> F
Coil Combine Mode	Adaptive Combine
Save uncombined	Off
Matrix Optimization	Off
Coil Focus	Flat
AutoAlign	---
Coil Select Mode	On - AutoCoilSelect

System - Adjustments

B0 Shim mode	Standard
B1 Shim mode	TrueForm
Adjust with body coil	Off
Confirm freq. adjustment	Off
Assume Dominant Fat	Off
Assume Silicone	Off
Adjustment Tolerance	Auto

System - Adjust Volume

Position	L20.4 P0.7 H23.7 mm
Orientation	Transversal
Rotation	0.00 deg
A >> P	200 mm
R >> L	200 mm
F >> H	103 mm
Reset	Off

System - pTx Volumes

B1 Shim mode	TrueForm
Excitation	Slab-sel.

System - Tx/Rx

Frequency 1H	123.250212 MHz
Correction factor	1
Gain	Low
Img. Scale Cor.	1.000
Reset	Off
? Ref. amplitude 1H	0.000 V

Physio - PACE

Resp. control	Off
Concatenations	1

Inline - Common

View sharing	Off
Flip angle	15.0 deg
Measurements	1
Burn time-to-center	Off
Temporal interpolation	1
3D centric reordering	Off
	null

Inline - Inline

Subtract	Off
Measurements	1
StdDev	Off
Liver registration	Off
Save original images	On

Inline - MIP

MIP-Sag	Off
MIP-Cor	Off
MIP-Tra	Off
MIP-Time	Off
Save original images	On

Inline - Soft Tissue

Wash - In	Off
Wash - Out	Off
TTP	Off
PEI	Off
MIP - time	Off
Measurements	1

Inline - Composing

Inline Composing	Off
Distortion Corr.	On
Mode	2D
Unfiltered images	Off

Inline - MapIt

Save original images	On
MapIt	None
Flip angle	15.0 deg
Measurements	1
Contrasts	1
TR	4.59 ms
TE	1.68 ms

Sequence - Part 1

Introduction	Off
Dimension	3D
Elliptical scanning	On
Asymmetric echo	Weak
Contrasts	1
Optimization	Min. TE
Multi-slice mode	Sequential
Bandwidth	300 Hz/Px

Sequence - Part 2

RF pulse type	Normal
Gradient mode	Fast
Excitation	Slab-sel.
RF spoiling	On
Incr. Gradient spoiling	Off

Sequence - Assistant

Mode	Off
Allowed delay	0 s

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\\Research Funded\RESEARCH\MVPS1F -Study on HOLD\MVP_lastmod2017Jun28\DIFF_RESOLVE_b1600_tra

TA: 6:44 PM: ISO Voxel size: 2.0×2.0×3.0 mmPAT: 2 Rel. SNR: 1.00 : resolve

Properties

Prio recon	Off
Load images to viewer	On
Inline movie	Off
Auto store images	On
Load images to stamp segments	Off
Load images to graphic segments	Off
Auto open inline display	Off
Auto close inline display	Off
Start measurement without further preparation	Off
Wait for user to start	Off
Start measurements	Single measurement

Routine

Slice group	1
Slices	24
Dist. factor	0 %
Position	L20.4 P0.7 H23.7 mm
Orientation	Transversal
Phase enc. dir.	A >> P
AutoAlign	---
Phase oversampling	30 %
FoV read	220 mm
FoV phase	100.0 %
Slice thickness	3.0 mm
TR	4630 ms
TE 1	55 ms
TE 2	87 ms
Concatenations	1
Filter	Distortion Corr.(2D)
Coil elements	BO2;SP4,5

Contrast - Common

TR	4630 ms
TE 1	55 ms
TE 2	87 ms
MTC	Off
Magn. preparation	None
Flip angle	180 deg
Fat suppr.	SPAIR
Fat sat. mode	Strong

Contrast - Dynamic

Averaging mode	Short term
Reconstruction	Magnitude
Measurements	1

Resolution - Common

FoV read	220 mm
FoV phase	100.0 %
Slice thickness	3.0 mm
Base resolution	110
Phase resolution	100 %
Phase partial Fourier	Off
Readout partial Fourier	5/8
Readout segments	5
Interpolation	Off

Resolution - iPAT

PAT mode	GRAPPA
Accel. factor PE	2
Ref. lines PE	72
Reference scan mode	EPI/separate

Resolution - Filter Image

Distortion Corr.	On
Mode	2D
Unfiltered images	Off
Prescan Normalize	Off

Resolution - Filter Rawdata

Raw filter	Off

Geometry - Common

Slice group	1
Slices	24
Dist. factor	0 %
Position	L20.4 P0.7 H23.7 mm
Orientation	Transversal
Phase enc. dir.	A >> P
FoV read	220 mm
FoV phase	100.0 %
Slice thickness	3.0 mm
TR	4630 ms
Multi-slice mode	Interleaved
Series	Interleaved
Concatenations	1

Geometry - AutoAlign

Slice group	1
Position	L20.4 P0.7 H23.7 mm
Orientation	Transversal
Phase enc. dir.	A >> P
AutoAlign	---
Initial Position	L20.4 P0.7 H23.7
L	20.4 mm
P	0.7 mm
H	23.7 mm
Initial Rotation	0.00 deg
Initial Orientation	Transversal

Geometry - Saturation

Sat. region	1
Thickness	60 mm
Position	L0.0 A100.0 H19.0 mm
Orientation	Coronal
Sat. region	2
Thickness	60 mm
Position	L0.0 P100.0 H19.0 mm
Orientation	Coronal
Fat sat. mode	Strong
Special sat.	None

Geometry - Tim Planning Suite

Set-n-Go Protocol	Off
Table position	H
Table position	24 mm

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Geometry - Tim Planning Suite

Inline Composing	Off

System - Miscellaneous

Positioning mode	ISO
Table position	H
Table position	24 mm
MSMA	S - C - T
Sagittal	R >> L
Coronal	A >> P
Transversal	H >> F
Coil Combine Mode	Adaptive Combine
Save uncombined	Off
Matrix Optimization	Off
Coil Focus	Flat
AutoAlign	---
Coil Select Mode	On - AutoCoilSelect

System - Adjustments

B0 Shim mode	Standard
B1 Shim mode	TrueForm
Adjust with body coil	Off
Confirm freq. adjustment	Off
Assume Dominant Fat	Off
Assume Silicone	Off
Adjustment Tolerance	Auto

System - Adjust Volume

Position	L20.4 P0.7 H23.7 mm
Orientation	Transversal
Rotation	0.00 deg
A >> P	220 mm
R >> L	220 mm
F >> H	72 mm
Reset	Off

System - pTx Volumes

B1 Shim mode	TrueForm

System - Tx/Rx

Frequency 1H	123.250212 MHz
Correction factor	1
Gain	High
Img. Scale Cor.	3.000
Reset	Off
? Ref. amplitude 1H	0.000 V

Physio - Signal1

1st Signal/Mode	None
TR	4630 ms
Concatenations	1

Diff - Neuro

Diffusion mode	3-Scan Trace
Diff. directions	3
Diffusion Scheme	Monopolar
Diff. weightings	2
b-value 1	0 s/mm²
b-value 2	1600 s/mm²
b-value 1	1
b-value 2	9
Diff. weighted images	Off
Trace weighted images	On
ADC maps	On

Diff - Neuro

FA maps	Off
Mosaic	Off
Tensor	Off
Noise level	0

Diff - Body

Diffusion mode	3-Scan Trace
Diff. directions	3
Diffusion Scheme	Monopolar
Diff. weightings	2
b-value 1	0 s/mm²
b-value 2	1600 s/mm²
b-value 1	1
b-value 2	9
Diff. weighted images	Off
Trace weighted images	On
ADC maps	On
Exponential ADC Maps	Off
FA maps	Off
Invert Gray Scale	Off
Calculated Image	Off
b-Value >=	0 s/mm²
Noise level	0

Diff - Composing

Inline Composing	Off
Distortion Corr.	On
Mode	2D
Unfiltered images	Off

Sequence - Part 1

Introduction	On
Dimension	2D
Contrasts	2
Optimization	Min. TE
Multi-slice mode	Interleaved
Echo spacing	0.34 ms
Bandwidth	988 Hz/Px

Sequence - Part 2

EPI factor	72
RF pulse type	Normal
Gradient mode	Fast
Reacquisition mode	Off

Sequence - Assistant

Mode	Off

Supplementary Appendix 2. Baseline patient characteristics based on PIRAD score among patients in the MRI arm

Characteristic	PIRADS 1-2	PIRADS 3	PIRADS 4-5
Age (years) (mean ±standard deviation)	67.9±7.3	65.3±7.0	69.3±7.3
Ethnic Background (%)			
White	157 (83.1%)	29 (90.6%)	21 (84.0%)
Black	1 (0.5%)	0 (0%)	0 (0%)
Asian	17 (9.0%)	1 (3.1%)	1 (4.0%)
Other	14 (7.4%)	2 (6.3%)	3 (12.0%)

MRI: magnetic resonance imaging