The contribution of multiparametric pelvic & whole body MR to interpretation of 18F-fluoromethylcholine or 68Ga-HBED-CC PSMA-11 PET/CT in patients with biochemical failure following radical prostatectomy

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Running title: Role of MR in FCH / PSMA PET in BCR

ABSTRACT

Purpose: To assess whether the addition of data from multiparametric pelvic (mpMR) and whole body MR (wbMR) to the interpretation of ^{18}F-fluoromethylcholine (FCH) or ^{68}Ga-HBED-CC PSMA-11 (PSMA) PET/CT (=PET) improves the detection of local tumor recurrence, or nodal and distant metastases in patients following radical prostatectomy with biochemical failure. **Methods:** The current analysis was performed as part of a prospective, multicenter trial on FCH / PSMA PET, mpMR and wbMR. Eligible men had elevated PSA (>0.2 ng/ml) and high-risk features (Gleason score >7, PSA doubling time < 10 months, or PSA>1.0 ng/ml) with negative/ equivocal conventional imaging. PET was interpreted with mp&wbMR in consensus by 2 radiologists and compared to prospective interpretation of PET or MR alone. Performance measures of each modality (PET, MR & PET/mp-wbMR) were compared for each radiotracer, for each individual patient (for FCH, or PSMA for patients who had PSMA PET), and to a composite reference standard. **Results:** There were 86 patients with PET (FCH [n=76] and/or PSMA [n=26]) who had mp&wbMR. Local tumor recurrence was detected in 20/76 (26.3%) on FCH PET/mpMR vs 11/76 (14.5%) on FCH PET (p= 0.039) and 11/26 (42.3%) on PSMA PET/mpMR vs 6/26 (23.1%) on PSMA PET (p=0.074). Per patient, PET/mpMR was more often positive for local tumor recurrence than PET (p=0.039) or mpMR (p=0.019). There were 20/86 (23.3%) patients with regional nodal metastases on both PET/wbMR, and PET (p=1.0) but only 12/86 (14%) on wbMR (p=0.061). Similarly, there were more nonregional metastases detected on PET/wbMR than on PET (p=0.683) and wbMR (p=0.074), but these differences did not reach significance.   Compared to the composite reference standard for the detection of disease beyond the prostatic fossa PET/wbMR, PET and wbMR had sensitivity of 50%, 50%, 8.3%, respectively & specificity of 97.1%, 97.1%, 94.1%, respectively. **Conclusion:** Interpretation of PET with mpMR resulted in a higher detection rate for local tumor recurrence in the prostate bed in men with biochemical failure following radical prostatectomy. However, the addition of wbMR to FCH/PSMA PET did not improve detection of regional or distant metastases.

INTRODUCTION

We recently published the results of an international, multicenter trial on ^{18}F-Fluoromethylcholine (FCH)/ ^{68}Ga-HBED-CC PSMA11 (PSMA) PET/CT (=PET) and multiparametric pelvic (mpMR) in men with high-risk features and biochemical failure after radical prostatectomy. The study showed that both FCH and PSMA PET had a high detection rates for extra prostate fossa disease in men with negative or equivocal conventional imaging and biochemical recurrence post radical prostatectomy. This impacted management and treatment responses to salvage fossa radiotherapy, suggesting an important role for PET in triaging men being considered for curative radiotherapy (*1*).   Study patients received mpMR to assess for local tumor recurrence and whole body MR (wbMR) to assess for nodal and distant metastases. mpMR has been previously validated as a robust imaging modality for detection of local recurrence in the prostate bed in men post radical prostatectomy for prostate cancer with biochemical failure, even at low serum PSA, and may help predict response to salvage radiotherapy (*2*). Comparison of mpMR to FCH PET has shown comparable results (*3,4*). Some authors have suggested that combining PET and MR would yield better results (*3*).   The purpose of the current analysis was to determine whether the addition of data from mpMR and wbMR to the interpretation of FCH or PSMA PET would improve the detection of local tumor recurrence, or nodal and distant metastases in this patient population.

MATERIALS & METHODS

This prospective, international multicenter trial was approved by all institutional ethics boards (clinicaltrials.gov identifier: NCT02131649). There were 91 eligible, consenting men with biochemical failure post radical prostatectomy and high-risk features being considered for curative intent salvage fossa radiotherapy prospectively recruited across the 8 participating sites across Australia, Canada and the United Kingdom between July 2014 and January 2017. All patients had biopsy confirmed prostate cancer, prior radical prostatectomy for pT1-T3, N0/Nx disease, a rising serum prostate serum antigen (PSA) ≥ 0.2ng/mL (3 consecutive rises documented a minimum of 2 weeks apart) and at least one high

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risk feature (PSA > 1.0 ng/ml, ≥pT3b, Gleason score > 7 or PSA doubling time ≤ 10 months). Negative or equivocal CT and bone scan within 12 weeks of enrolment was required. Exclusion criteria included significant sarcomatoid or spindle cell or neuroendocrine small cell components, proven metastatic disease, evidence of unequivocal disease outside the prostate bed on conventional imaging, refusing salvage prostate bed radiotherapy or androgen deprivation therapy within 6 months prior to enrolment.

Study interventions were comprised of FCH PET, mpMR and wbMR within a 2 week period, with men in Australia undergoing an additional PSMA PET scan within the same timeframe.

Image interpretation

PET was prospectively interpreted in consensus by experienced readers locally and at a central site (Peter MacCallum Cancer Centre, Melbourne Australia). mpMR was read in consensus by 2 local radiologists with expertise in interpretation of prostate MR and the wbMR was interpreted centrally (University College London & Royal Marsden, London, UK). Interpretation criteria using a 4-point certainty scale were previously described (1). In brief, focal radiotracer uptake in prostate bed, or nodule with intermediate high T2 signal abnormality, and early arterial-phase enhancement on dynamic contrast enhanced MRI were considered positive for local tumor recurrence. Lymph nodes were considered positive if distinct radiotracer uptake was identified, excluding nodes at sites where reactive lymphadenopathy is common, such as the groin. Focal skeletal uptake above background marrow activity and or a focus of signal abnormality on MR, especially if associated with restricted diffusion, were considered positive for bone metastasis unless explained by a benign abnormality such as fracture or degenerative change.

All imaging results were uploaded to a central database. For the current analysis, a combined interpretation of PET & mp-wbMR was performed independently by 2 of 3 board certified readers experienced in interpreting PET and MR [UM, SC, BH]. The readers were able to review all datasets (PET, mpMR and wbMR) on dedicated workstations. Results were tabulated by a further radiologist [NT], who identified discordance between the readers in the detection of local tumor recurrence, or nodal or distant metastatic disease. Discordant cases were re-reviewed by the original readers. If a consensus could not be reached, a third tie breaker independent read was obtained.   The combined PET and MR

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read was compared to prospective PET and mp & wbMR interpretation.

Imaging Acquisition Protocols

PET. All men underwent immediate dynamic pelvic (10 mins) and then delayed whole-body FCH PET/CT with coverage from skull base to proximal thighs at 60 minutes after intravenous administration of FCH (3.6 MBq/kg to a maximum of 400MBq at time of injection). A low-dose, non-contrast CT scan was initially performed for attenuation correction and localization. The initial dynamic acquisition was acquired over the pelvis at 4 x 30s, 4 x 1min and 2 x 2min. Subsequently, the whole-body PET acquisition was obtained. In those undergoing PSMA, imaging from vertex to mid thighs was undertaken at least 60 minutes following the intravenous administration of Ga^{68} PSMA HBEDD -11 (2.0MBq/kg, to a maximum 200MBq at time of injection). PET imaging was stored on a centralised secure server for central review.

mpMR. Multiparametric pelvic MRI was performed as per local institutional protocols but were harmonized to include small field-of-view, pelvic T2 axial and coronal sequences, axial pelvic dynamic contrast-enhanced MR after administration of gadolinium-based contrast, and optional axial pelvic diffusion weighted imaging with b50 and b1000 diffusion weightings. Following acquisition, MRI imaging was uploaded to a centralized online secure server and centrally reviewed for quality.

wbMR. The wbMR acquisition included Dixon or T1 weighted imaging (WI) and axial DWI at 1.5 or 3 Tesla (T) using gradients of b=50 and 1000 s/mm^2 with coverage from skull base to mid thighs. For T1WI, precontrast fat saturated volume interpolated gradient echo imaging (3D) was performed and a Dixon based technique was preferred. Imaging was performed either in the coronal plane using an isotropic image resolution of 2 or 3 mm adjusted to allow a maximum breath-hold time for acquisition time of 20s per station, or in the axial plane with a 5mm slice thickness. For DWI, any fat saturation technique could be used with a slice thickness of 5 to 7mm.

Composite Reference Standard

As per study protocol, biopsy of imaging-positive lesions was encouraged but not mandated. Overall, 12% (11/91) men underwent biopsy of scan positive sites of disease. Composite standard of reference incorporating biopsy and targeted treatment response is presented in detail in our prior

publication (*1*). In brief, patients with positive imaging for disease beyond the prostatic fossa were considered true positive for metastatic disease if biopsy confirmed or if insufficient therapy response to pelvic radiotherapy only was observed. Patients with negative imaging for disease beyond the prostatic fossa were considered true negative if therapy response was observed. Patients that received androgen deprivation therapy without a biopsy outside of the prostate bed and patients that underwent surveillance without having a biopsy performed outside of the prostate bed were excluded. Treatment response was defined as a drop in PSA of >50% from pre- treatment levels in the absence of androgen deprivation therapy at the time of PSA assessment at least 6 months post-treatment. Men who were placed on androgen deprivation therapy as part of treatment were not included in assessment of initial treatment response.

Data Comparisons & Statistical Analysis

The detection of local tumor recurrence in prostate bed on PET and mpMR was compared for each modality (PET, mpMR, or PET & mpMR) and for each radiopharmaceutical separately. Furthermore, comparison of detection of local tumor recurrence for each modality was performed for individual patients. In the latter comparison, patients who had both FCH and PSMA PET, only PSMA PET data was used. Similarly, the detection of disease beyond the prostate fossa was compared on PET, wbMR and PET & wbMR for each radiopharmaceutical and for individual patients.   Finally, for the detection of disease beyond the prostate fossa, the diagnostic accuracy of each modality (sensitivity, specificity, PPV, NPV and accuracy) was determined using the composite reference standard described above. Comparison of detection rates of the different imaging modalities was performed using two-sided McNemar's Chi-squared test. A p-value of 0.05 or less was deemed statistically significant.

RESULTS

There were 91 patients included in the study with a median age of 64 years (IQR: 59-69) and a median of 23 months (IQR: 9-46.5) from radical prostatectomy. These patients had stage T2 (34/91; 37.5%), T3a (35/91; 39.5%), or T3b (21/91; 23%) tumors, and a Gleason score of 6-7 in 60/91 (67%) and

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Gleason score of 8-10 in 29/91 (32%). The median PSA at time of imaging was 0.42 ng/ml (IIQR: 0.29-0.93), and the median PSA doubling time was 5 months (IQR: 3.3-7.6). Further details regarding patient demographics including therapy received after PET were previously published (1). Complete imaging datasets (PET, mpMR of pelvis, and wbMR) were available in 86/91 (94.5%) study patients who comprised the cohort for the current analysis. There were 102 PET scans for these patients including 76/86 (88.4%) FCH PET and 26/86 (30.2%) PSMA PET [Figure 1].

Combined PET & MR Interpretation

Initial interpretation by 2 of 3 independent reviewers was concordant in 64/102 (62.8%) of datasets. The majority of discordant lesions were in the prostate bed (25/38; 65.8%). Consensus was reached in a second review of imaging by same 2 reviewers in 33/38 (86.8%) discordant PET & MR datasets. A third independent interpretation was used to adjudicate the remaining discordant cases.

Local Recurrence in Prostate Bed

FOR EACH MODALITY AND RADIOPHARMACEUTICAL. FCH PET with mpMR (PET/mpMR) was more frequently positive for local tumor recurrence in the prostate bed compared to FCH PET (20/76 [26.3%] vs 11/76 [14.5%]), respectively; only 8 were concordant (p=0.039; Odds ratio (OR), 0.25; 95% Confidence Interval (CI), 0.045-0.926). Similarly, PSMA PET/mpMR was more often positive for local tumor recurrence in the prostate bed than PSMA PET (11/26 [42.3%] vs 6/26 [23.1%], respectively); however this did not reach significance for the current cohort (p=0.074; OR, 0; 95% CI, 0-1.091).

FOR INDIVIDUAL PATIENTS. The detection of local tumor recurrence on PET/mpMR and PET or mpMR interpreted separately was performed for 86 unique patients. For patients who had PSMA and FCH PET, only data from PSMA PET was used for this analysis. Overall there were 26/86 (30.2%) patients with PSMA PET/mpMR and 60/86 (69.8%) patients with FCH PET/mpMR (Table 1). PET/ mpMR was more often positive for local tumor recurrence than PET alone (p=0.039, OR, 4; 95%CI, 1.079-22.088) or mpMR (p=0.019, OR, 0.294; 95%CI, 0.085-0.831).

Presence of Nodal or Distant Metastases

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The detection of nodal metastases for each modality (PET/wbMR, PET, and wbMR) is presented in Table 2. There were 20 patients with regional nodal metastases on both PET and PET/wbMR, and 18 of these were concordant (p=1.0; OR, 1; 95% CI, 0.072-13.796). PET/wbMR suggested more regional nodal metastases than wbMR (20/86 [23.3%] vs 12/86 [14%], respectively); however, this did not reach significance (p=0.061; OR, 0.273, 95% CI, 0.049-1.032). Only 9/32 (28.1%) patients suggested as having nodal metastases with either modality were positive on both.

The detection of non-regional nodal (M1a category) and distant metastases (M1b, M1c) are presented in Table 3. There were more M1a-M1c metastases detected on PET/wbMR than on PET (p=0.683; OR, 0.5; 95% CI, 0.045-3.489) and wbMR (p=0.074; OR, 0; 95%CI, 0-1.091), but this was not significant.

Nodal or Distant Metastases Compared to Composite Reference Standard

Of the 86 study patients, there were 58 individual patients with composite standard of reference available for presence of disease beyond the prostatic fossa (Table 4). The performance measures of FCH/PSMA PET/wbMR were similar to that of FCH/PSMA PET with discordance in 3 cases only. The sensitivity, specificity, PPV, NPV and overall accuracy for both modalities (PET and PET/wbMR) was 50%, 97.1%, 92.3%, 73.3% and 77.6%, respectively. The performance measures for wbMR for detection of disease beyond the prostatic fossa were generally inferior to PET and PET/wbMR, with a sensitivity, specificity, PPV, NPV and overall accuracy of 8.3%, 94.1%, 50%, 59.3% and 58.6%, respectively.

DISCUSSION

The role of PET/MR in oncology is evolving. A recent review of initial PET/MR studies in over 2300 patients has suggested that PET/MR has similar diagnostic performance as PET/CT (5). In patients with prostate cancer, MR may have an advantage over CT in detecting tumor in the prostate or prostate fossa and in detecting bone metastases; however, the incremental value of MR to information provided from PET remains uncertain and likely varies according to the specific clinical scenario. The current study assessed the contribution of data obtained from mpMR and wbMR to FCH or PSMA PET in assessing

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local tumor recurrence and metastases in men with biochemical failure after radical prostatectomy.   Of note, in our study, MR was acquired separate from PET/CT rather than with a hybrid PET/MR scanner. Dedicated fusion software enabled multi-modality image fusion when needed.

Previous studies have shown that for patients with serum PSA ≤ 1 ng/ml, mpMR detects local recurrence in the prostate bed in 11-21% patients (6,7). Our results were similar, with a detection rate of 15.1% for the entire cohort. The addition of mpMR data to PET nearly doubled tumor detection for both FCH and PSMA PET with PET/mpMR outperforming PET alone or mpMR alone. Interpretation of local tumor recurrence in the prostate fossa may be challenging, and this represented the most common lesion for discordance between readers at PET/mpMR. These findings are in line with a previously published study in which a head-to-head comparison of ^{11}C-choline-PET/MR and ^{11}C-choline-PET/CT in 75 patients with biochemical failure showed that local tumor recurrence was identified more often on PET/MR than on PET/CT (8).   The improved lesion detection with PET/mpMR over PET and mpMR alone may be explained by the moderately high sensitivity of both modalities in identifying local tumor recurrence while exploiting different tumor characteristics [Figure 2]. For example, mpMR could demonstrate tumor nodules that are masked by urine activity in the urethra on PET. In other instances, the presence of an abnormality on both imaging modalities, albeit subtle in some cases, may enable a more confident diagnosis of local tumor recurrence [Figure 3].

Overall, wbMR identified nodal or distant metastases in 13/86 (15.1%) patients in our study, similar to results in a previous trial in which metastases were identified in 13.2% of patients (7). When interpreting PET in conjunction with wbMR findings. MR did not significantly contribute to the overall performance of PET in detecting lymph node or distant metastases. There are a few potential explanations for the limited contribution of wbMR data in this study. First, FCH and PSMA PET are more sensitive than MR in identifying nodal metastases, the most common metastatic site in this patient population (9,10). Second, the extended field of view of wbMR, typically from top of skull to upper thighs, limits the spatial resolution of MR. In our protocol, multiparametric, high resolution, small field of view imaging was obtained for the prostate bed (=mpMR), but the wbMR was performed with a broader field of

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view and slice thickness up to 5 - 7mm for DWI. The metastatic deposits beyond the prostatic fossa in this patient population, who had negative or equivocal CT and bone scintigraphy, tend to be relatively small and prone to partial volume effects with the wbMR imaging parameters used, limiting lesion detectability. Furthermore, many wb MR protocols, including the one utilized in this trial, are lengthy with acquisition time of approximately 1 hour or longer, depending on the number of sequences included. This may result in more frequent motion artifact which may further degrade MR image quality, especially for sequences with low signal-to-noise ratios, such as DWI (one of the imaging staples of the current wbMR protocol), or for small lesion pathology (*11,12*).   Our results suggest that the sensitivity of hybrid imaging is likely driven by the more sensitive imaging modality, with significant contribution of both modalities when detection is moderate or high with incomplete overlap in lesion detection, as was the case for detection of local tumor recurrence by mpMR and PET in our study.   We were unable to demonstrate a benefit for the addition of wbMR to FCH/PSMA PET to guide therapy planning in men with biochemical failure post radical prostatectomy.

The main strengths of the current study include the collection of data from harmonized PET and MR imaging protocols across multiple centres across the world, and the combination of local and central data analysis. However, the study does have several limitations. First, due to inclusion of multiple institutions with variable available imaging platforms, the PET and MR data were obtained separately and not on integrated PET/MR scanners. However, the MR protocol for the current study was developed to evaluate the prostate fossa and remainder of body for recurrent or metastatic tumor, with similar coverage as the FCH/PSMA PET, much akin to MR obtained with integrated PET/MR.   Second, two different PET tracers were used in this study, with overlap in some patients. To overcome this, we analyzed the performance measures of each tracer separately and assessed the performance measures for unique patients independently. This still may have resulted in limited statistical power, especially for PSMA, given their small number of patients in that cohort. Third, most lesions detected by each modality were not confirmed histologically. We did however utilize a composite reference standard, albeit imperfect, to compare the performance measures of PET, MR and PET/MR for metastatic disease. This reference standard could not be used to determine whether PET or mpMR were correct in their characterization of the prostate bed.   Although PET/mpMR could improve detection of local recurrence in the prostate bed,

this is unlikely to impact patient management as in the absence of disease outside of the prostate fossa patients would likely receive salvage pelvic radiotherapy.

In conclusion, interpretation of PET with mpMR resulted in a higher detection rate for local tumor recurrence in the prostate bed in men with biochemical failure following radical prostatectomy. However, the addition of wbMR to FCH/PSMA PET/CT did not improve detection of regional or distant metastases. These results may aid in refining PET/MR imaging protocols for this patient population.

ACKNOWLEDGEMENTS

KEY POINTS

Question: Does data from mpMR and/or wbMR improve detection of tumor recurrence or metastases in patients with FCH or PSMA PET/CT in men with biochemical recurrence following radical prostatectomy?

Pertinent findings: In this prospective multicenter trial, interpretation of PET/CT with mpMR resulted in a higher detection rate for local tumor recurrence in the prostate bed; however, the addition of wbMR to PET/CT did not improve detection of regional or distant metastases.

Implications for Patient Care: These results may aid in refining PET/MR imaging protocols for this patient population.

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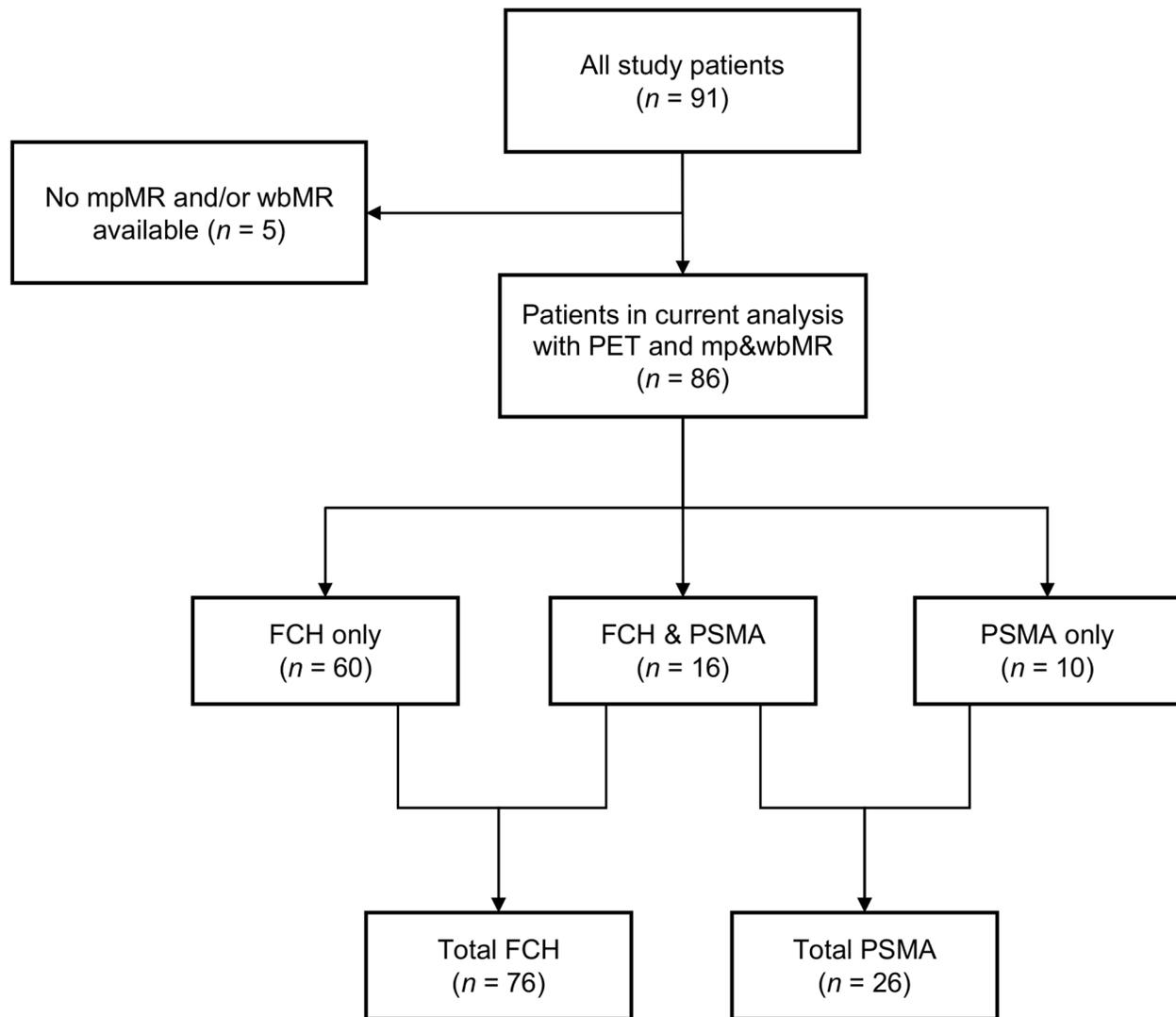
Figure 1. Flow chart depicting study patients included and radiopharmaceuticals used.
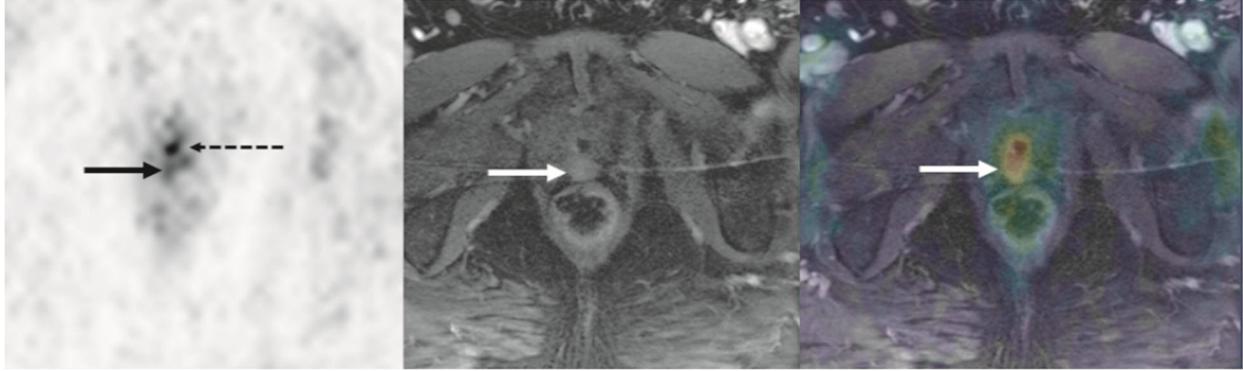
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Figure 2. 65 year-old man post radical prostatectomy with biochemical recurrence (PSA, 1.1 ng/ml).

Axial PSMA PET/mpMR image. PET shows intense radiotracer activity in urethra at level of surgical anastomosis (dotted arrow), and ill-defined moderate uptake posterior to the urethra, not interpreted prospectively as tumor on PET. Fused PET/MR image (right) shows the radiotracer uptake corresponds to a focus of abnormal enhancement on dynamic contrast-enhanced MR (arrow, middle and right) suggestive of local tumor recurrence.
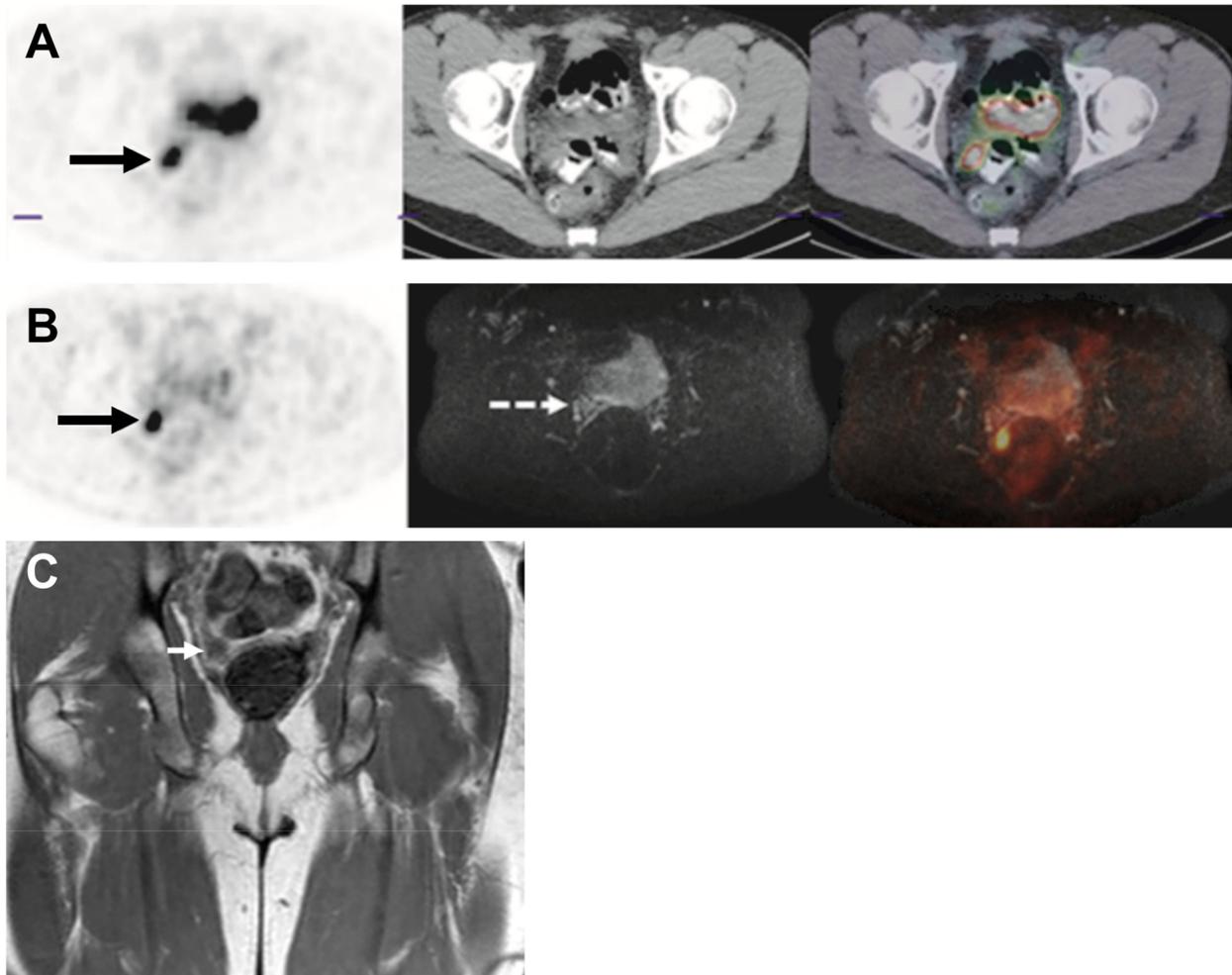
Figure 3. 48 year-old man post radical prostatectomy with biochemical recurrence (serum PSA, 0.4 ng/ml).

A. Axial PSMA-PET/CT image (PET image, left; CT, middle; fused PET/CT, right). PET shows focal intense PSMA uptake in bed of right seminal vesicle (arrow), along cranial aspect of surgical clips (not shown). No definitive CT correlate could be identified. **B.** Axial PET/MR image in same patient (PET image, left; Diffusion weighted image [b-value = 1000 s/mm^{2}], middle; and fused PET/MR image, right) **& C**. Coronal Dixon T1 weighted image of pelvis: Focal intense PMSA uptake in bed of right seminal vesicle (B, solid arrow, left). On diffusion weighted MR [b=1000 s/mm^{2}] (B, dotted arrow, middle) and Coronal Dixon T1 image (C, solid arrow), subtle soft tissue nodule is seen in same location, not prospectively appreciated on interpretation of MR alone.

Tables

FCH or PSMA PET/mpMR vs PET *			
	PET/mpMR (+)	*PET/mpMR (-)*	Total
PET (+)	13 (15.1%)	3 (3.5%)	16 (18.6%)
PET (-)	12 (14%)	58 (67.4%)	70 (81.4%)
Total	25 (29.1%)	61 (70.9%)	86 (100%)
FCH or PSMA PET/mpMR vs mpMR ¥			
	PET/mpMR (+)	*PET/mpMR (-)*	Total
mpMR (+)	8 (9.3%)	5 (5.8%)	13 (15.1%)
mpMR(-)	17 (19.8%)	56 (65.1%)	73 (84.9%)
Total	25 (29.1%)	61 (70.9%)	86 (100%)

Table 1. Detection of local tumor recurrence in prostate bed for FCH or PSMA PET & mpMR

(=PET/mpMR) versus PET/CT (=PET) or mpMR alone. Percentage of total is in parentheses. ***** p=0.039;

¥ p=0.019

FCH/ PSMA PET/wbMR vs PET *			
	PET/wbMR (+)	PET/wbMR (-)	Total
PET (+)	18 (21%)	2 (2.3%)	20 (23.3%)
PET (-)	2 (2.3%)	64 (74.4%)	66 (76.7%)
Total	20 (23.3%)	66 (76.7%)	86 (100%)
FCH/ PSMA PET/wbMR vs wbMR ¥			
	PET/wbMR (+)	PET/wbMR (-)	Total
wbMR (+)	9 (10.5%)	3 (3.5%)	12 (14%)
wbMR(-)	11 (12.8%)	63 (73.3%)	74 (86.1%)
Total	20 (23.3%)	66 (76.7%)	86 (100%)

Table 2. Detection of regional nodal metastases for each modality. FCH/ PSMA PET & whole body MR (=PET/wbMR), FCH/PSMA PET/CT (=PET), and whole body MR (=wbMR). Percentage of total is in parentheses. * p=1.0; ¥ p=0.061.

FCH or PSMA PET/wbMR vs PET *			
	PET/wbMR (+)	PET/wbMR (-)	Total
PET (+)	2 (2.3%)	2 (2.3%)	4 (4.7%)
PET (-)	4 (4.7%)	78 (90.7%)	82 (95.3%)
Total	6 (7%)	80 (93%)	86 (100%)
FCH or PSMA PET/wbMR vs wbMR ¥			
	PET/wbMR (+)	PET/wbMR (-)	Total
wbMR (+)	1 (1.2%)	0 (0%)	1 (1.2%0
wbMR(-)	5 (5.8%)	80 (93%)	85 (98.8%)
Total	6 (7%)	80 (93%)	86 (100%)

Table 3. Detection of nonregional nodal and distant metastases for each modality. FCH/ PSMA
PET & whole body MR (=PET/wbMR), FCH/PSMA PET/CT (=PET), and whole body MR (=wbMR).
Percentage of total is in parentheses. ***** p=0.683; **¥** p=0.074.

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	True Positive	True Negative	False Negative	False Positive
FCH or PSMA PET	12 (20.7%)	33 (56.9%)	12 (20.7%)	1 (1.7%)
wbMR	2 (3.5%)	32 (55.2%)	22 (37.9%)	2 (3.5%)
FCH or PSMA PET/wbMR	12 (20.7%)	33 (56.9%)	12 (20.7%)	1 (1.7%)

Table 4. Metastatic disease: comparison of each modality to the composite reference standard.

FCH or PSMA PET/CT (=PET), whole body MR (=wbMR) and FCH or PSMA PET & whole body MR (=PET/wbMR). Percentage of total is in parentheses.

The contribution of multiparametric pelvic & whole body MR to interpretation of ^{18}F-fluoromethylcholine or ^{68}Ga-HBED-CC PSMA-11 PET/CT in patients with biochemical failure following radical prostatectomy

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