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EVIDENCE REVIEW

New frontiers in focal therapy for prostate cancer: Prostate-specific membrane antigen positron emission tomography/magnetic resonance imaging

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Abstract

Imaging has a central role in the context of focal therapy (FT) for prostate cancer (PCa). Prostate-specific membrane antigen (PSMA) positron emission tomography/magnetic resonance imaging (PET/MRI) is a novel imaging modality that combines the morpho-functional information of MRI with the molecular characterization of PET. Some papers reported the potential advantages of PSMA PET/MRI in different clinical scenarios. Limited evidence on PSMA PET/MRI is available in the setting of FT. PSMA PET/MRI can be an effective imaging modality for detecting primary PCa and seems to provide accurate local staging of primary PCa. PSMA PET/MRI also shows high performance for restaging and detecting tumor recurrence. The higher soft-tissue contrast and the reduction of ionizing radiation are the main advantages reported in the literature compared to PET/computed tomography. PSMA PET/MRI could represent a turning point in the management of patients with PCa in the context of FT. Further studies are needed to confirm its applications in this specific clinical

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setting.

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Core Tip: Prostate-specific membrane antigen positron emission tomography/magnetic resonance imaging can be an effective imaging modality for detecting primary and recurrent prostate cancer, besides it seems to provide accurate local staging and restaging. Multiparametric magnetic resonance imaging is considered the standard imaging modality in the context of focal therapy; however, the diagnostic performance of prostate-specific membrane antigen positron emission tomography/magnetic resonance imaging make it an excellent candidate as a technique of choice in this setting.

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INTRODUCTION

Prostate-specific membrane antigen (PSMA) is a membrane protein that is overexpressed in the vast majority of prostate cancer (PCa)[1]. PSMA can be used as a positron emission tomography (PET) target through specific ligands labeled with radioisotopes. PSMA PET/computed tomography (CT) is an established imaging technique for the evaluation of biochemical recurrence (BCR) of PCa[2] and showed possible applications also for tumor detection, staging, treatment planning, and assessment of response to therapy[3-6]. PSMA PET/magnetic resonance imaging (MRI) is a hybrid imaging technique that combines the morphological information of MRI with the molecular data of PET. MRI provides excellent anatomical characterization and soft tissue contrast, whereas PSMA PET offers a reliable molecular characterization of the tumor[7]. The first applications of PSMA PET/MRI in the PCa setting were described in 2013[8]; since that time, several papers reported the potential applications of this imaging modality in different clinical scenarios[9,10]. Multiparametric (mp) MRI is considered the standard imaging modality for tumor detection, local staging and follow-up in the focal therapy (FT) setting[11]; however, the demonstration of several intrinsic limitations of this technique highlighted the need to investigate alternative imaging modalities, including PSMA PET/CT and PSMA PET/MRI[12,13].

PRIMARY PROSTATE CANCER DETECTION AND STAGING WITH PROSTATE-SPECIFIC MEMBRANE ANTIGEN POSITRON EMISSION TOMOGRAPHY / MAGNETIC RESONANCE IMAGING

Eiber *et al*[14] found that patient-based sensitivity for the tumor detection of mpMRI, PSMA PET, and PSMA PET/MRI was 66%, 92%, and 98%, respectively. Patient-based sensitivity of PSMA PET and PSMA PET/MRI statistically significantly outperformed mpMRI (P = 0.001 and P < 0.001), while no significant difference was observed between PSMA PET imaging and PSMA PET/MRI (P = 0.250). With cut-off scores of 3 for mpMRI and 4 for PSMA PET and PSMA PET/MRI, lesion-based sensitivity and specificity of PSMA PET/MRI were 76% and 97% respectively, while mpMRI and PSMA PET showed less sensitivity (58% and 64%) and specificity (82% and 94%). A concordance subanalysis revealed that both mpMRI and PSMA PET were able to

identify most tumors; however, each technique detected tumor-involved areas that were negative in the other modality, this contributed to the observed superiority of PSMA PET/MRI. No significant correlation was found between quantitative PET parameters and Gleason score (GS). Al-Bayati *et al*[15] found that lesion-based sensitivity for the tumor detection of mpMRI, PSMA PET, and PSMA PET/MRI was 59%, 81%, and 88%, respectively. PSMA PET and PSMA PET/MRI had a significantly higher sensitivity than mpMRI (P = 0.03 and P = 0.003), while they did not show a significant difference in between them (P = 0.5). The lesion-based specificity of mpMRI, PSMA PET, and PSMA PET/MRI was 66%, 100%, and 100%, respectively. PSMA PET and PSMA PET/MRI rated 4 and 6 Lesions as equivocal (5-point Likert scale 3), while mpMRI classified 15 Lesions as indeterminate (PI-RADS 3). In a considerable proportion of equivocal results with mpMRI, PSMA PET led to a correct shift towards higher malignancy suspicion. Hicks *et al*[16] showed the improved region-specific sensitivity for the tumor detection of PSMA PET/MRI compared to mpMRI. Besides, the authors found a significant correlation between tumor maximum standardized uptake value and GS. Park *et al*[17] concluded that PSMA PET/MRI offers incremental value over a dedicated mpMRI for preoperative PCa localization and staging. Sugawara *et al*[18] reported a higher accuracy for primary tumor diagnosis of PSMA PET/MRI compared to mpMRI, PSMA PET or clinical factors alone (*i.e.*, digital rectal examination and PSA), and the combination of PSMA PET/MRI with clinical profile improved the characterization of lesions; besides, the authors reported the significant association of maximum standardized uptake value with GS. Freitag *et al*[19] concluded that the lymph node (LN) and bone metastases were accurately and reliably depicted by PSMA PET/MRI with very low discordance compared to PSMA PET/CT. Both PET techniques were able to identify metastases in normal-sized LN (71.9%). Visibility of LN was significantly higher with MRI compared to CT using T1-w CE (P = 0.013), T2-w fat-saturated (P < 0.0001), and DWI (P < 0.0001) sequences. Two PSMA PET-positive bone metastases could not be confirmed morphologically using CT, but it was possible with MRI.

Maurer *et al*[20] found that PSMA PET/MRI and PSMA PET/CT for LN staging performed significantly superior to morphological imaging alone (CT or MRI) on a patient- (P = 0.002) and template-based analysis (P < 0.001). In contrast, no substantial difference between CT and MRI as morphological imaging components of PSMA PET was recorded. Thalgott *et al*[21] assessed the diagnostic potential of PSMA PET/MRI compared to preoperative staging nomograms and concluded that PSMA PET/MRI and clinical nomograms performed equally well to determine the clinical stage; besides, PSMA PET provided additional anatomical information useful for therapeutic planning. Grubmüller *et al*[22] reported the correct identification of PCa with PSMA PET/MRI in 122 patients (97.5%). The accuracy of T-and LN-staging in 80 patients was 82.5% (95% Confidence interval: 73%-90%) and 93% (95% Confidence interval: 84%-98%), respectively. Noteworthy, PSMA PET/MRI changed the therapeutic strategy in 28.7% of the patients. Muehlematter *et al*[23] compared the diagnostic accuracy of mpMRI and PSMA PET/MRI for the detection of extracapsular extension (ECE) and seminal vesicle infiltration. PSMA PET/MRI showed lower region-specific sensitivity for detection of ECE (90% *vs* 94%; P = 0.007) and seminal vesicle infiltration (94% *vs* 98%; P = 0.001), while patient-specific sensitivity for the detection of ECE was higher with PSMA PET/MRI (69% *vs* 46%; P = 0.04). No other significant differences were found. Ferraro *et al*[24] found that the patient-based sensitivity, specificity, PPV, and NPV for the LN metastases detection of PSMA PET/MRI were 58%, 98%, 88%, and 90%, respectively. The model combining PSA, Gleason score, and PSMA PET visual analysis of LN showed a tendency to improve patient selection for LN dissection over the currently used clinical nomograms. Kaufmann *et al*[25] investigated the accuracy for T-and LN-staging of PSMA PET/MRI, surprisingly reporting discordant results compared to the previous ones. The authors observed similar overall PCa detection between mpMRI and PET/MRI (both ^{11}C-choline and ^{68}Ga-PSMA). mpMRI was found to be more accurate than PET for T-staging. In particular, PET underestimated the local tumor extent and no additional value for PET concerning the primary tumor extend was found. mpMRI showed no inferiority compared to PET/MRI in N-staging, and the author reported the limitation of PET/MRI in detecting small LN metastases independent of the radiotracer used.

RECURRENT PROSTATE CANCER DETECTION AND RESTAGING WITH PROSTATE-SPECIFIC MEMBRANE ANTIGEN POSITRON EMISSION TOMOGRAPHY / MAGNETIC RESONANCE IMAGING

Afshar-Oromieh *et al*[26] compared PSMA PET/CT and PSMA PET/MRI in BCR patients. The authors concluded that, outside the "halo artifacts" around the bladder and at the level of the kidneys, PSMA PET/MRI was more accurate and enabled a subjectively easier evaluation of the images than PSMA PET/CT, allowing to clarify unclear findings on PSMA PET/CT. Freitag *et al*[27] reported that 93 (78.2%) BCR patients had PSMA-positive lesions. Eighteen (15.1%) subjects had local recurrences in PET/MRI, while only 9 (7.6%) in PET/CT (P = 0.004). Bladder-to-local recurrence distance was identified as a statistically significant predictor of PSMA PET-positivity (P = 0.028), contrary to local recurrence size (P = 0.84). Hope *et al*[28] found that with PSMA PET/MRI and PSMA PET/CT the disease was detected in 103 (82%) BCR patients and major changes in the management was preferred in 67 (53.2%) cases; however, no sub-analysis was performed to compare the two PET techniques. Lütje *et al*[29] showed that in 14 (29.2%) patients neither PSMA PET/CT nor PSMA PET/MRI found lesions and 9 (19.7%) were excluded due to artifacts around the bladder. In the other 25 (52.1%) subjects, PSMA PET/MRI *vs* PSMA PET/CT identified 14 *vs* 9 recurrences in the prostate bed, 23 *vs* 20 PET-positive lymph nodes, and 4 *vs* 4 PSMA PET-positive bone lesions, respectively. The higher detection of tumor recurrences in the prostate bed of PSMA PET/MRI was attributed to the superior soft-tissue contrast of MRI component. Schiller *et al*[30] found that lesions suspicious for PCa were detected in 27/31 cases (87.1%) with PSMA PET/MRI or PSMA PET/CT compared to negative CT/MRI. Furthermore, 14 patients (45.2%) had a changed staging result with PSMA PET compared to CT/MRI. Grubmüller *et al*[31] showed that PSMA-positive lesions were found in 100 (85.5%) BCR patients with PET/CT or PET/MRI, reporting a detection rate of 65% for PSA levels of 0.2-0.5 ng/mL. PSMA PET detected lesions in 67 (57.3%) subjects who had no suspicious with MRI or CT and changed therapeutic management in 74.6% of them. The authors did not compare the performance of two PET modalities. Kranzbühler *et al*[32] reported positive PSMA PET/MRI in 44 (78.6%) BCR patients. Suspicious lesions were detected in 44.4%, 72.7%, 80%, 95.2% of subjects with PSA levels of < 0.2, 0.2-0.5, 0.5-2.0, > 2.0 ng/mL respectively. The detection rate of MRI was significantly lower than PSMA PET/MRI (24%), while the overall detection rate of PSMA PET was comparable with PSMA PET/MRI (76%). The high detection rate (54.5%) for recurrent PCa, even at low PSA levels (< 0.5 ng/mL), were confirmed in a subsequent study of the same group[33]. Burger *et al*[34] investigated PSMA PET/MRI's performance for the localization of disease recurrence in patients undergoing high-intensity focused ultrasound with proven significant PCa on transperineal template biopsy not detected with mpMRI. It is necessary to emphasize that this is the only paper available in literature analyzing PSMA PET/MRI in the specific context of FT. PSMA PET was positive in 6 (60%) patients. No false-positive lesions were reported. All negative subjects had GS 3 + 4 disease, while all lesions with GS 4 + 3 or higher were detected. The quadrant-based sensitivity, specificity, PPV, and NPV of PET were 55%, 100%, 100%, and 85%, respectively. Abufaraj *et al*[35] assess the accuracy of PSMA PET/CT or PSMA PET/MRI LN staging in patients with BCR after RP undergoing LN dissection. Patient-based sensitivity was 100%. At regional analysis, sensitivity of PET ranged from 72% to 100%, specificity from 96% to 100%, PPV from 95% to 100%, NPV from 93% to 100%, diagnostic accuracy from 95% to 98%. No differences in diagnostic performance were found between PSMA PET/CT and PSMA PET/MRI. The PPV in patients with a PSA level ≥ 1.4 ng/mL was almost always 100% in all regions and subregions except the presacral region (93%). Guberina *et al*[36] reported that tumor recurrence was localized in 62 (66.7%) BCR patients based on combined PSMA PET/CT and PSMA PET/MRI reading. The sensitivity of PSMA PET/MRI and PSMA PET/CT was 98.8 % and 93.2%, respectively. PSMA PET/MRI detected 148 out of 150 Lesions described in PSMA PET/CT (missing two LN lesions) and other 11 Lesions (5 LN lesions and 6 Local recurrences). A significant difference (P = 0.031) between PSMA PET/CT and PSMA PET/MRI for local recurrence diagnosis was found.

SUMMARY OF EVIDENCE

PSMA PET/MRI may be an effective imaging modality to detect primary PCa,

showing a higher accuracy compared to mpMRI alone[14-16]. It provides accurate local staging of primary PCa; however, there are contradictory results in this setting when its reliability is compared to other imaging modalities[20,24,25]. PSMA PET/MRI also shows high performance for restaging and detecting tumor recurrence, but its superiority over PSMA PET/CT has not yet been clearly demonstrated[8,31,35] (Table 1). PSMA PET/MRI seems to favorably integrate the current clinical nomograms[21,24]. Artifacts can reduce the diagnostic performance of PSMA PET around the bladder and kidneys[26,27]. The reduction of ionizing radiation and the higher soft-tissue contrast and the main advantages reported in the literature compared to PSMA PET/CT, while the long duration, the high cost, the poor standardization of the technique, and the low availability are some relevant limitations[37,38].

CONCLUSION

The ideal imaging technique for prostate cancer patients in the focal therapy setting is not yet available but encouraging data regarding PSMA PET/MRI are emerging from the literature.

PSMA PET/MRI could represent a turning point in the management of patients with prostate cancer in the context of focal therapy; however, well-designed studies are needed to clarify the role of PSMA PET/MRI in this specific clinical setting.

Table 1 Diagnostic performance of imaging techniques in the focal therapy setting

	mpMRI	PSMA PET/CT	PSMA PET/MRI
Primary tumor detection	Intermediate	Intermediate/High	High
Loco-regional staging	Intermediate/High	Intermediate/High	Intermediate/High
Tumor recurrence detection	Intermediate	Intermediate/High	Intermediate/High

FT: Focal therapy; PSMA: Prostate-specific membrane antigen; PET: Positron emission tomography; CT: Computed tomography; MRI: Magnetic resonance imaging; mp: Multiparametric.

REFERENCES

1 **Bravaccini S**, Puccetti M, Bocchini M, Ravaioli S, Celli M, Scarpi E, De Giorgi U, Tumedei MM, Raulli G, Cardinale L, Paganelli G. PSMA expression: a potential ally for the pathologist in prostate cancer diagnosis. *Sci Rep* 2018; **8**: 4254 [PMID: 29523813 DOI: 10.1038/s41598-018-22594-1]

2 **Heidenreich A**, Aus G, Bolla M, Joniau S, Matveev VB, Schmid HP, Zattoni F; European Association of Urology. [EAU guidelines on prostate cancer]. *Actas Urol Esp* 2009; **33**: 113-126 [PMID: 19418833 DOI: 10.1016/s0210-4806(09)74110-5]

3 **Treglia G**, Annunziata S, Pizzuto DA, Giovanella L, Prior JO, Ceriani L. Detection Rate of ^{18}F-Labeled PSMA PET/CT in Biochemical Recurrent Prostate Cancer: A Systematic Review and a Meta-Analysis. *Cancers (Basel)* 2019; **11** [PMID: 31126071 DOI: 10.3390/cancers11050710]

4 **Han S**, Woo S, Kim YJ, Suh CH. Impact of ^{68}Ga-PSMA PET on the Management of Patients with Prostate Cancer: A Systematic Review and Meta-analysis. *Eur Urol* 2018; **74**: 179-190 [PMID: 29678358 DOI: 10.1016/j.eururo.2018.03.030]

5 **Hofman MS**, Lawrentschuk N, Francis RJ, Tang C, Vela I, Thomas P, Rutherford N, Martin JM, Frydenberg M, Shakher R, Wong LM, Taubman K, Ting Lee S, Hsiao E, Roach P, Nottage M, Kirkwood I, Hayne D, Link E, Marusic P, Matera A, Herschtal A, Iravani A, Hicks RJ, Williams S, Murphy DG; proPSMA Study Group Collaborators. Prostate-specific membrane antigen PET-CT in patients with high-risk prostate cancer before curative-intent surgery or radiotherapy (proPSMA): a prospective, randomised, multicentre study. *Lancet* 2020; **395**: 1208-1216 [PMID: 32209449 DOI: 10.1016/S0140-6736(20)30314-7]

6 **Artigas C**, Flamen P, Charlier F, Levillain H, Wimana Z, Diamand R, Albisinni S, Gil T, Velthoven RV, Peltier A, Gestel DV, Roumeguere T, Otte FX. ^{68}Ga-PSMA PET/CT-based metastasis-directed radiotherapy for oligometastatic prostate cancer recurrence after radical prostatectomy. *World J Urol* 2019; **37**: 1535-1542 [PMID: 30824985 DOI: 10.1007/s00345-019-02701-1]

7 **Barbosa FG**, Queiroz MA, Nunes RF, Marin JFG, Buchpiguel CA, Cerri GG. Clinical perspectives of PSMA PET/MRI for prostate cancer. *Clinics (Sao Paulo)* 2018; **73**: e586s [PMID: 30281701 DOI: 10.6061/clinics/2018/e586s]

8 **Afshar-Oromieh A**, Haberkorn U, Hadaschik B, Habl G, Eder M, Eisenhut M, Schlemmer HP, Roethke MC. PET/MRI with a 68Ga-PSMA ligand for the detection of prostate cancer. *Eur J Nucl Med Mol Imaging* 2013; **40**: 1629-1630 [PMID: 23817686 DOI: 10.1007/s00259-013-2489-5]

9 **Hoffmann MA**, Wieler HJ, Baues C, Kuntz NJ, Richardsen I, Schreckenberger M. The Impact of 68Ga-PSMA PET/CT and PET/MRI on the Management of Prostate Cancer. *Urology* 2019; **130**: 1-12 [PMID: 30986486 DOI: 10.1016/j.urology.2019.04.004]

10 **Annunziata S**, Pizzuto DA, Treglia G. Diagnostic Performance of PET Imaging Using Different Radiopharmaceuticals in Prostate Cancer According to Published Meta-Analyses. *Cancers (Basel)* 2020; **12** [PMID: 32759672 DOI: 10.3390/cancers12082153]

11 **Tay KJ**, Scheltema MJ, Ahmed HU, Barret E, Coleman JA, Dominguez-Escrig J, Ghai S, Huang J, Jones JS, Klotz LH, Robertson CN, Sanchez-Salas R, Scionti S, Sivaraman A, de la Rosette J, Polascik TJ. Patient selection for prostate focal therapy in the era of active surveillance: an International Delphi Consensus Project. *Prostate Cancer Prostatic Dis* 2017; **20**: 294-299 [PMID: 28349978 DOI: 10.1038/pcan.2017.8]

12 **Le JD**, Tan N, Shkolyar E, Lu DY, Kwan L, Marks LS, Huang J, Margolis DJ, Raman SS, Reiter RE. Multifocality and prostate cancer detection by multiparametric magnetic resonance imaging: correlation with whole-mount histopathology. *Eur Urol* 2015; **67**: 569-576 [PMID: 25257029 DOI: 10.1016/j.eururo.2014.08.079]

13 **Johnson DC**, Raman SS, Mirak SA, Kwan L, Bajgiran AM, Hsu W, Maehara CK, Ahuja P, Faiena I, Pooli A, Salmasi A, Sisk A, Felker ER, Lu DSK, Reiter RE. Detection of Individual Prostate Cancer Foci *via* Multiparametric Magnetic Resonance Imaging. *Eur Urol* 2019; **75**: 712-720 [PMID: 30509763 DOI: 10.1016/j.eururo.2018.11.031]

14 **Eiber M**, Weirich G, Holzapfel K, Souvatzoglou M, Haller B, Rauscher I, Beer AJ, Wester HJ, Gschwend J, Schwaiger M, Maurer T. Simultaneous ^{68}Ga-PSMA HBED-CC PET/MRI Improves the Localization of Primary Prostate Cancer. *Eur Urol* 2016; **70**: 829-836 [PMID: 26795686 DOI: 10.1016/j.eururo.2015.12.053]

15 **Al-Bayati M**, Grueneisen J, Lütje S, Sawicki LM, Suntharalingam S, Tschirdewahn S, Forsting M,

Rübben H, Herrmann K, Umutlu L, Wetter A. Integrated 68Gallium Labelled Prostate-Specific Membrane Antigen-11 Positron Emission Tomography/Magnetic Resonance Imaging Enhances Discriminatory Power of Multi-Parametric Prostate Magnetic Resonance Imaging. *Urol Int* 2018; **100**: 164-171 [PMID: 29393268 DOI: 10.1159/000484695]

16 **Hicks RM**, Simko JP, Westphalen AC, Nguyen HG, Greene KL, Zhang L, Carroll PR, Hope TA. Diagnostic Accuracy of ^{68}Ga-PSMA-11 PET/MRI Compared with Multiparametric MRI in the Detection of Prostate Cancer. *Radiology* 2018; **289**: 730-737 [PMID: 30226456 DOI: 10.1148/radiol.2018180788]

17 **Park SY**, Zacharias C, Harrison C, Fan RE, Kunder C, Hatami N, Giesel F, Ghanouni P, Daniel B, Loening AM, Sonn GA, Iagaru A. Gallium 68 PSMA-11 PET/MR Imaging in Patients with Intermediate- or High-Risk Prostate Cancer. *Radiology* 2018; **288**: 495-505 [PMID: 29786490 DOI: 10.1148/radiol.2018172232]

18 **Sugawara E**, Nikaido H. Properties of AdeABC and AdeIJK efflux systems of Acinetobacter baumannii compared with those of the AcrAB-TolC system of Escherichia coli. *Antimicrob Agents Chemother* 2014; **58**: 7250-7257 [PMID: 25246403 DOI: 10.1128/AAC.03728-14]

19 **Freitag MT**, Radtke JP, Hadaschik BA, Kopp-Schneider A, Eder M, Kopka K, Haberkorn U, Roethke M, Schlemmer HP, Afshar-Oromieh A. Comparison of hybrid (68)Ga-PSMA PET/MRI and (68)Ga-PSMA PET/CT in the evaluation of lymph node and bone metastases of prostate cancer. *Eur J Nucl Med Mol Imaging* 2016; **43**: 70-83 [PMID: 26508290 DOI: 10.1007/s00259-015-3206-3]

20 **Maurer T**, Gschwend JE, Rauscher I, Souvatzoglou M, Haller B, Weirich G, Wester HJ, Heck M, Kübler H, Beer AJ, Schwaiger M, Eiber M. Diagnostic Efficacy of (68)Gallium-PSMA Positron Emission Tomography Compared to Conventional Imaging for Lymph Node Staging of 130 Consecutive Patients with Intermediate to High Risk Prostate Cancer. *J Urol* 2016; **195**: 1436-1443 [PMID: 26682756 DOI: 10.1016/j.juro.2015.12.025]

21 **Thalgott M**, Düwel C, Rauscher I, Heck MM, Haller B, Gafita A, Gschwend JE, Schwaiger M, Maurer T, Eiber M. One-Stop-Shop Whole-Body ^{68}Ga-PSMA-11 PET/MRI Compared with Clinical Nomograms for Preoperative T and N Staging of High-Risk Prostate Cancer. *J Nucl Med* 2018; **59**: 1850-1856 [PMID: 29794224 DOI: 10.2967/jnumed.117.207696]

22 **Grubmüller B**, Baltzer P, Hartenbach S, D'Andrea D, Helbich TH, Haug AR, Goldner GM, Wadsak W, Pfaff S, Mitterhauser M, Balber T, Berroteran-Infante N, Grahovac M, Babich J, Seitz C, Kramer G, Susani M, Mazal P, Kenner L, Shariat SF, Hacker M, Hartenbach M. PSMA Ligand PET/MRI for Primary Prostate Cancer: Staging Performance and Clinical Impact. *Clin Cancer Res* 2018; **24**: 6300-6307 [PMID: 30139879 DOI: 10.1158/1078-0432.CCR-18-0768]

23 **Muehlematter UJ**, Burger IA, Becker AS, Schawkat K, Hötker AM, Reiner CS, Müller J, Rupp NJ, Rüschoff JH, Eberli D, Donati OF. Diagnostic Accuracy of Multiparametric MRI *vs* ^{68}Ga-PSMA-11 PET/MRI for Extracapsular Extension and Seminal Vesicle Invasion in Patients with Prostate Cancer. *Radiology* 2019; **293**: 350-358 [PMID: 31502937 DOI: 10.1148/radiol.2019190687]

24 **Ferraro DA**, Muehlematter UJ, Garcia Schüler HI, Rupp NJ, Huellner M, Messerli M, Rüschoff JH, Ter Voert EEGW, Hermanns T, Burger IA. ^{68}Ga-PSMA-11 PET has the potential to improve patient selection for extended pelvic lymph node dissection in intermediate to high-risk prostate cancer. *Eur J Nucl Med Mol Imaging* 2020; **47**: 147-159 [PMID: 31522272 DOI: 10.1007/s00259-019-04511-4]

25 **Kaufmann S**, Kruck S, Gatidis S, Hepp T, Thaiss WM, Hennenlotter J, Schwenck J, Scharpf M, Nikolaou K, Stenzl A, Reischl G, la Fougère C, Bedke J. Simultaneous whole-body PET/MRI with integrated multiparametric MRI for primary staging of high-risk prostate cancer. *World J Urol* 2020; **38**: 2513-2521 [PMID: 31907632 DOI: 10.1007/s00345-019-03066-1]

26 **Afshar-Oromieh A**, Haberkorn U, Schlemmer HP, Fenchel M, Eder M, Eisenhut M, Hadaschik BA, Kopp-Schneider A, Röthke M. Comparison of PET/CT and PET/MRI hybrid systems using a 68Ga-labelled PSMA ligand for the diagnosis of recurrent prostate cancer: initial experience. *Eur J Nucl Med Mol Imaging* 2014; **41**: 887-897 [PMID: 24352789 DOI: 10.1007/s00259-013-2660-z]

27 **Freitag MT**, Radtke JP, Afshar-Oromieh A, Roethke MC, Hadaschik BA, Gleave M, Bonekamp D, Kopka K, Eder M, Heusser T, Kachelriess M, Wieczorek K, Sachpekidis C, Flechsig P, Giesel F, Hohenfellner M, Haberkorn U, Schlemmer HP, Dimitrakopoulou-Strauss A. Local recurrence of prostate cancer after radical prostatectomy is at risk to be missed in ^{68}Ga-PSMA-11-PET of PET/CT and PET/MRI: comparison with mpMRI integrated in simultaneous PET/MRI. *Eur J Nucl Med Mol Imaging* 2017; **44**: 776-787 [PMID: 27988802 DOI: 10.1007/s00259-016-3594-z]

28 **Hope TA**, Aggarwal R, Chee B, Tao D, Greene KL, Cooperberg MR, Feng F, Chang A, Ryan CJ, Small EJ, Carroll PR. Impact of ^{68}Ga-PSMA-11 PET on Management in Patients with Biochemically Recurrent Prostate Cancer. *J Nucl Med* 2017; **58**: 1956-1961 [PMID: 28522741 DOI: 10.2967/jnumed.117.192476]

29 **Lütje S**, Cohnen J, Gomez B, Grüneisen J, Sawicki L, Rübben H, Bockisch A, Umutlu L, Pöppel TD, Wetter A. Integrated ^{68}Ga-HBED-CC-PSMA-PET/MRI in patients with suspected recurrent prostate cancer. *Nuklearmedizin* 2017; **56**: 73-81 [PMID: 28401244 DOI: 10.3413/Nukmed-0850-16-09]

30 **Schiller K**, Sauter K, Dewes S, Eiber M, Maurer T, Gschwend J, Combs SE, Habl G. Patterns of failure after radical prostatectomy in prostate cancer - implications for radiation therapy planning after ^{68}Ga-PSMA-PET imaging. *Eur J Nucl Med Mol Imaging* 2017; **44**: 1656-1662 [PMID: 28646463 DOI: 10.1007/s00259-017-3746-9]

31 **Grubmüller B**, Baltzer P, D'Andrea D, Korn S, Haug AR, Hacker M, Grubmüller KH, Goldner GM, Wadsak W, Pfaff S, Babich J, Seitz C, Fajkovic H, Susani M, Mazal P, Kramer G, Shariat SF, Hartenbach M. ^{68}Ga-PSMA 11 Ligand PET imaging in patients with biochemical recurrence after

radical prostatectomy - diagnostic performance and impact on therapeutic decision-making. *Eur J Nucl Med Mol Imaging* 2018; **45**: 235-242 [PMID: 29075832 DOI: 10.1007/s00259-017-3858-2]

32 **Kranzbühler B**, Nagel H, Becker AS, Müller J, Huellner M, Stolzmann P, Muehlematter U, Guckenberger M, Kaufmann PA, Eberli D, Burger IA. Clinical performance of ^{68}Ga-PSMA-11 PET/MRI for the detection of recurrent prostate cancer following radical prostatectomy. *Eur J Nucl Med Mol Imaging* 2018; **45**: 20-30 [PMID: 29032394 DOI: 10.1007/s00259-017-3850-x]

33 **Kranzbühler B**, Müller J, Becker AS, Garcia Schüler HI, Muehlematter U, Fankhauser CD, Kedzia S, Guckenberger M, Kaufmann PA, Eberli D, Burger IA. Detection Rate and Localization of Prostate Cancer Recurrence Using ^{68}Ga-PSMA-11 PET/MRI in Patients with Low PSA Values ≤ 0.5 ng/mL. *J Nucl Med* 2020; **61**: 194-201 [PMID: 31375566 DOI: 10.2967/jnumed.118.225276]

34 **Burger IA**, Müller J, Donati OF, Ferraro DA, Messerli M, Kranzbühler B, Ter Voert EEGW, Muehlematter UJ, Rupp NJ, Mortezavi A, Eberli D. ^{68}Ga-PSMA-11 PET/MR Detects Local Recurrence Occult on mpMRI in Prostate Cancer Patients After HIFU. *J Nucl Med* 2019; **60**: 1118-1123 [PMID: 30683764 DOI: 10.2967/jnumed.118.221564]

35 **Abufaraj M**, Grubmüller B, Zeitlinger M, Kramer G, Seitz C, Haitel A, Baltzer P, Hacker M, Wadsak W, Pfaff S, Wiatr T, Mitterhauser M, Shariat SF, Hartenbach M. Prospective evaluation of the performance of [^{68}Ga]Ga-PSMA-11 PET/CT(MRI) for lymph node staging in patients undergoing superextended salvage lymph node dissection after radical prostatectomy. *Eur J Nucl Med Mol Imaging* 2019; **46**: 2169-2177 [PMID: 31254037 DOI: 10.1007/s00259-019-04361-0]

36 **Guberina N**, Hetkamp P, Ruebben H, Fendler W, Grueneisen J, Suntharalingam S, Kirchner J, Puellen L, Harke N, Radtke JP, Umutlu L, Hadaschik BA, Herrmann K, Forsting M, Wetter A. Whole-Body Integrated [^{68}Ga]PSMA-11-PET/MR Imaging in Patients with Recurrent Prostate Cancer: Comparison with Whole-Body PET/CT as the Standard of Reference. *Mol Imaging Biol* 2020; **22**: 788-796 [PMID: 31482413 DOI: 10.1007/s11307-019-01424-4]

37 **Ehman EC**, Johnson GB, Villanueva-Meyer JE, Cha S, Leynes AP, Larson PEZ, Hope TA. PET/MRI: Where might it replace PET/CT? *J Magn Reson Imaging* 2017; **46**: 1247-1262 [PMID: 28370695 DOI: 10.1002/jmri.25711]

38 **Bouchelouche K**, Choyke PL. Prostate-specific membrane antigen positron emission tomography in prostate cancer: a step toward personalized medicine. *Curr Opin Oncol* 2016; **28**: 216-221 [PMID: 26967720 DOI: 10.1097/CCO.0000000000000277]

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